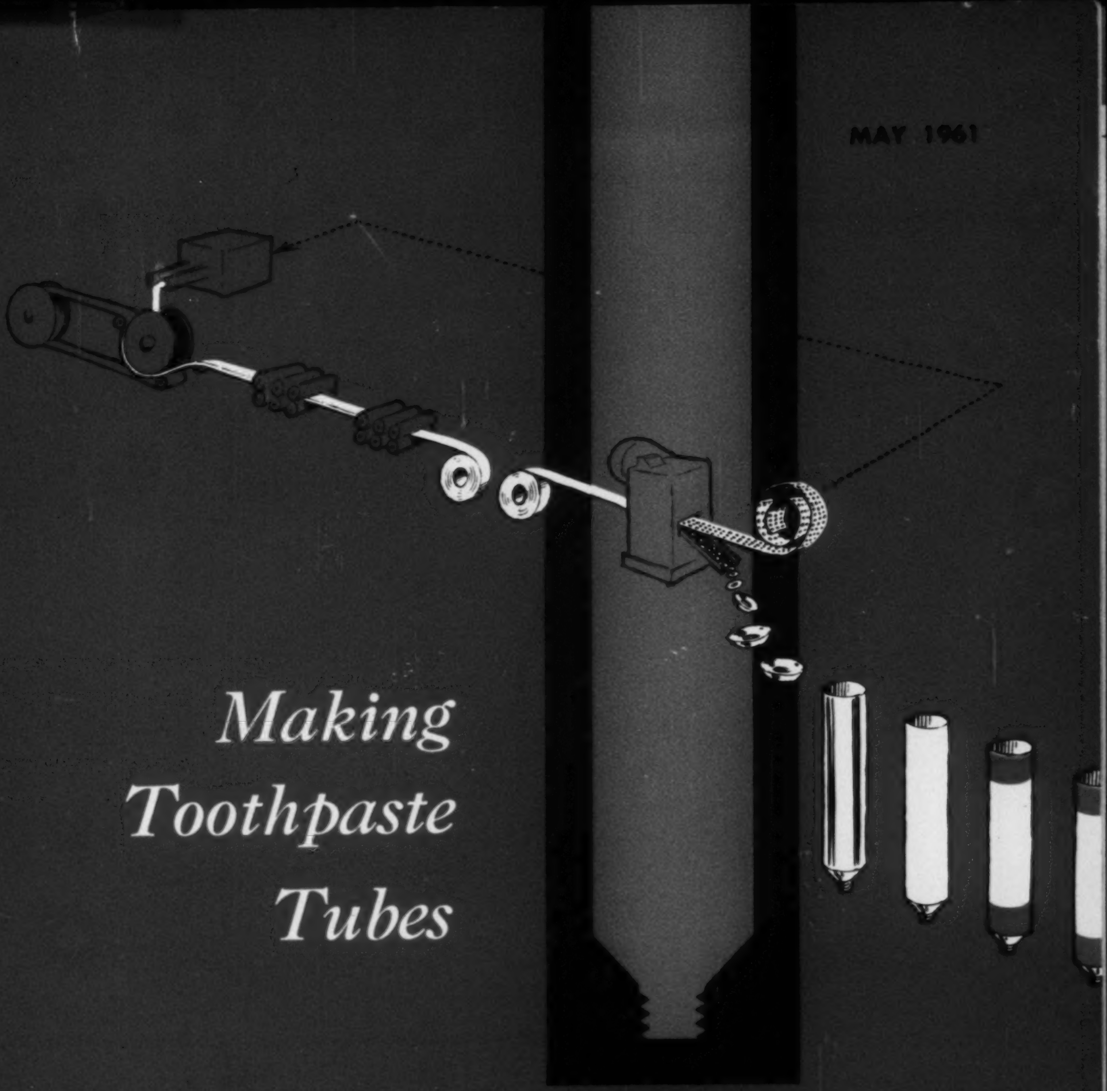
AUTOMATION

MAY 1961



Making Toothpaste Tubes

THE MAGAZINE OF AUTOMATIC MANUFACTURING OPERATIONS

- Tomorrow's Integrated Offices and Plants
- Controlling with Magnetic Tape
- Mechanical-Hydraulic Drive
- Elements of Positioning Controls

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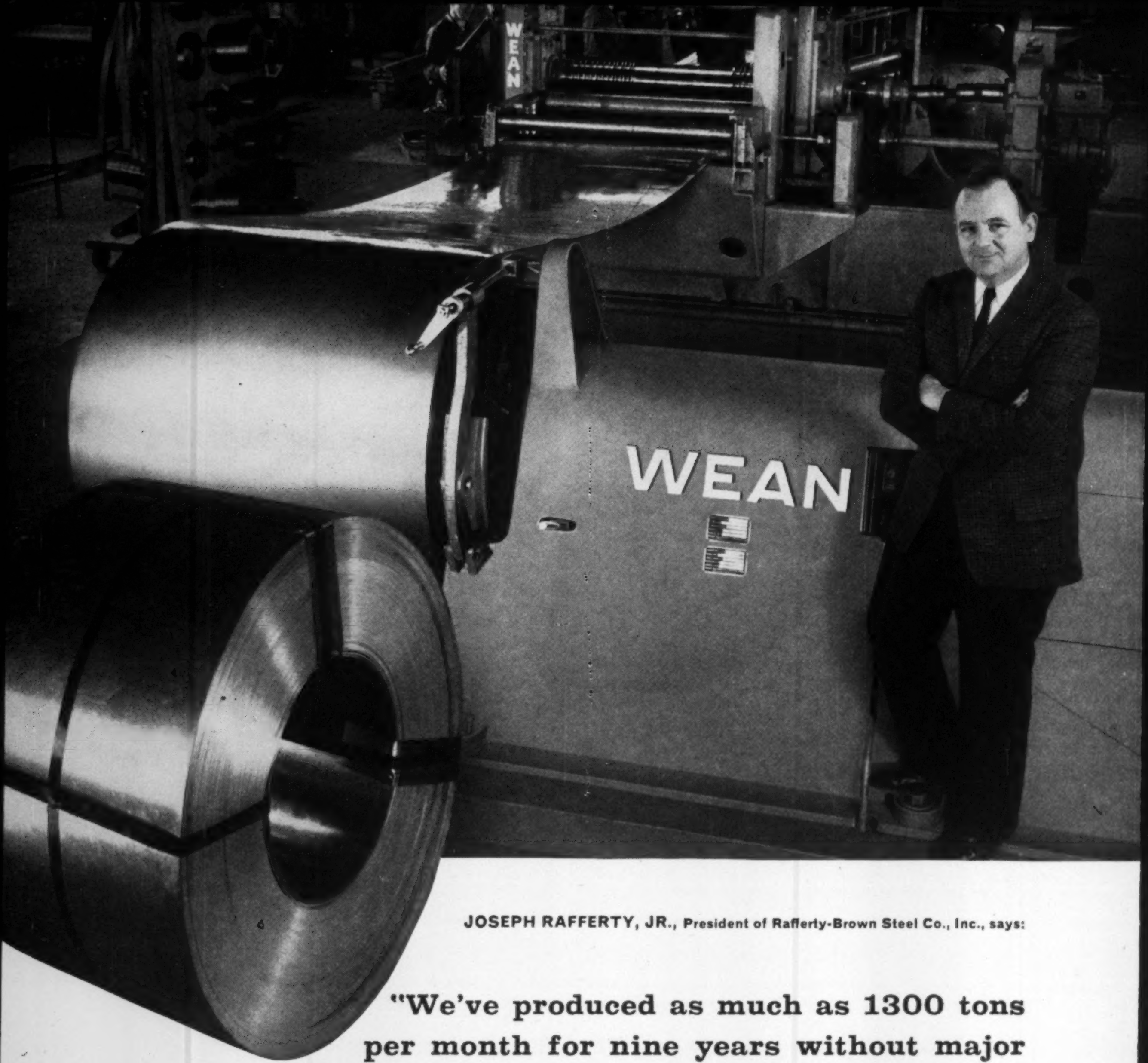
A PENTON PUBLICATION



JOSEPH RAFFERTY, JR., President of Rafferty-Brown Steel Co., Inc., says:

"We've produced as much as 1300 tons per month for nine years without major maintenance on our Wean Slitting Line. Much of the time, this 48-inch Wean line has operated on a three-shift basis, helping us to economically meet our customers' needs for hot rolled, cold rolled and silicon steel coils. We've also used the Wean line for slitting aluminum coils. With this kind of dependable performance, we're exceptionally proud of the line."

Mr. Rafferty's experience has been duplicated many times by other steel warehousing firms that have used rugged Wean Equipment in applying the *coil processing concept* to cut inventory, production and material costs. If you process 500 or more tons per month of flat-rolled metals, write for our new brochure, "Coil Processing," which explains the concept and economics of continuous coil processing.

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The McKAY MACHINE COMPANY (metalworking) • The WEAN ENGINEERING COMPANY, Inc. (primary steel)

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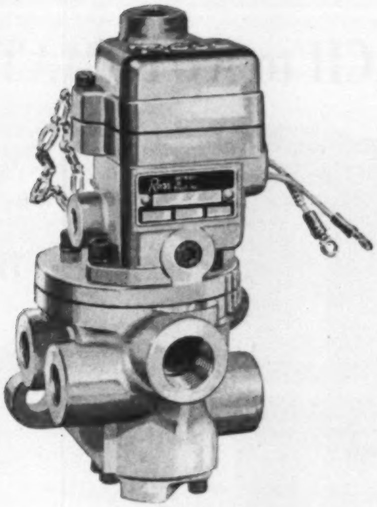

this small valve can do a big valve's work

Ross

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This story has made the Ross Headline valve series a "standard" in the world of valvedom in just six short months. There is nothing "exotic" about it. Our designers and manufacturing engineers have simply been able to create an economical inline valve that will pass a greater volume of air, valve size-for-valve size, than any other valve made. The Headline valve thus in many instances permits you to use a smaller valve than you could use before. Since this has been done without compromising Ross traditional quality, and long-life is thus taken for granted, the "Headline" series then represents probably the best valve value available today. Straightways, 3-ways and 4-ways. Pipe sizes, ¼″ through 1½″.

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For other Ross valves see our catalog in Sweets Product Design File.

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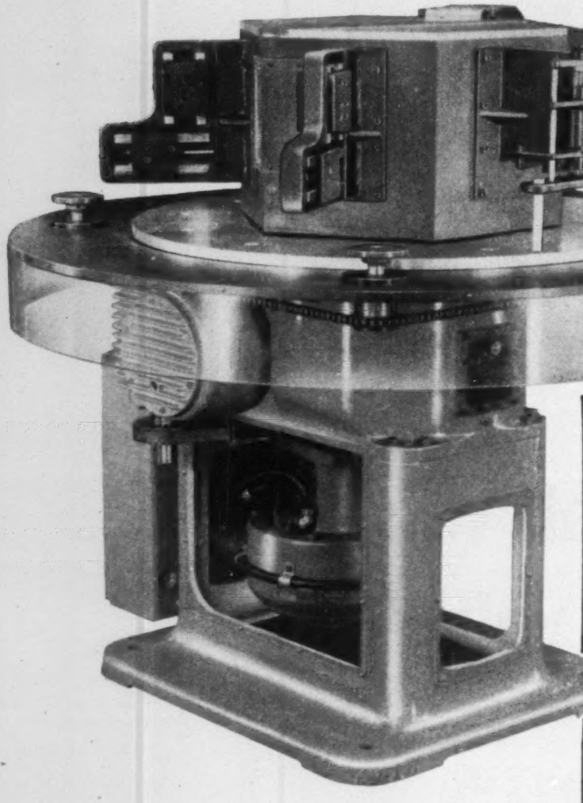
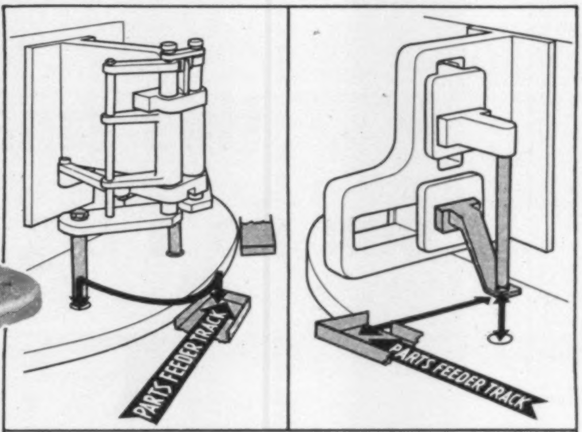
A NEW APPROACH to AUTOMATIC ASSEMBLY...



The machine tool concept to reduce equipment costs



Two of the standard cam actuated "pick & place" and "push & guide" stations. Each serves two dial positions. Shaded areas indicate those components attached by the user.

For the first time, medium size plants can employ automatic assembly to compete with large scale manufacturers because high volume is no longer a prerequisite to automatic production.

Ferguson's new approach to automatic assembly problems provides a standard rotary transfer machine complete with work stations that furnish parts placing motions right to the dial. The user only adds minor parts holding and positioning devices designed to conform to his production items. At the end of a production run *he changes set-up, as he would for any machine tool*, for operations on a different assembly.

Low initial cost of this standard machine means a fast pay-off on investment. Design versatility makes it adaptable for many uses and guards against obsolescence. And, as with any quality production machine tool, it is built for year-after-year performance with only normal maintenance practices.

SEND FOR CATALOG NO. 602— showing the many things we can do to help you improve automation techniques. Our engineers are ready to help you with any problem. They will start from scratch or redesign present equipment. Write us today.

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Magazine of
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A PENTON PUBLICATION

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Penton Building, Cleveland 13, Ohio

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automation outlook

Better Answers

TREMENDOUS SCOPE and breadth of the American economy poses a serious barrier to general understanding of its functioning. Against this reality many people have difficulty in appraising the over-all influences of today's remarkable technological progress.

Some are worried and with good cause. Even though numerous attempts, ranging from homely to sophisticated, have been made to explain some of the many intertwined factors at work, there remains the uncertain feeling that technological change presages the obsolescence of the workman. As job displacement takes place and the employable ranks grow, suitable new areas for endeavor seem to be hidden in the pale beyond. What cannot be readily seen or counted gives rise to doubt and suspicion. Statistics offer little consolation.

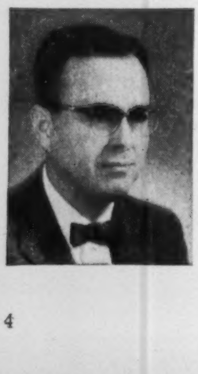
Where is technological advancement leading? For one thing, industry itself has great need to study and understand today's trends fully. Silence or platitude on the part of business is more and more being taken as evidence of unconcern over most problems that arise from shifts and changes taking place—among these being displacement and unemployment of the unskilled. Failure of industrial leaders to take the forefront in explaining the issues at stake, proposing solutions suitable for the years ahead, and actively educating the public as well as employees will result in increasing difficulties for business. Explosive growth in the ranks of job seekers in the coming year makes the issue crystal clear. Better answers must be forthcoming.

Haphazard approach and laissez-faire attitudes of the past can hardly be expected to serve the needs today. In a recent issue of *Business Horizons*, Henry J. Kester and Harold A. Wolf indict pension funds as a major factor in creating labor obsolescence—through their influence as a major supplier to industry of ready new capital for improving the technological efficiency of plant and equipment.

Kester and Wolf present a mighty potent argument for using pension funds *properly* by investing them for human capital improvement. Rather than assuring comfortable benefits so many years hence, the proposal envisions continuing security by reinvestment of these funds for improving the workingman's education and competence. By investing this money in the people themselves, a better equipped staff would be assured for plant operations under advancing technology. Any employee so educated could more easily move into newer jobs being created.

Only one channel exists for coping with labor obsolescence in a dynamic technological economy and that is continuing education on a broad base. The only real security for any workman lies in the development of his own capabilities to the greatest degree possible.

Perhaps there is real merit in a reappraisal of pension funds for use as a capital investment in personnel rather than long-range deferred wages.



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BPA NBP

...Fluid Power news

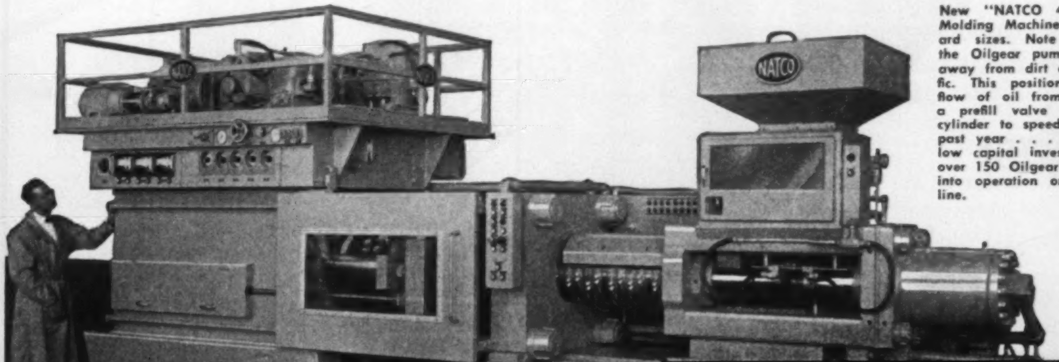
1921 1961
OILGEAR
40
Years of Fluid Power

Report No. 11,602 From Oilgear *Application-Engineering* Files

HOW OILGEAR ENGINEERING TEAMWORK AIDED DESIGN OF NEW INJECTION MOLDING MACHINES

CUSTOMER: *National Automatic Tool Co., Inc. (NATCO), Richmond, Indiana*

DATA: As a preliminary guide to design and production of a new line of injection molding machines, "NATCO" engineers used a 31-question survey of molders operating eight or more machines. This survey confirmed "NATCO" engineers' experienced opinion that: 1. Most unplanned downtime on injection molding machines was due primarily to hydraulic system problems . . . shocks caused by sudden shifts in pressure or direction of flow through valves "under pressure," causing pipe and welded joint fatigue, bent valve stems, cracked or over-stressed tie-rods and cylinders. 2 Molders' demands for higher speeds and pressures further amplify these problems. *Basic "NATCO" Requirements:* 1. A hydraulic system to eliminate shock, hammering, and the resulting costly downtime . . . must provide continuous, dependable, high-speed operation. 2. Both slow and high-speed closing, as well as two-speed injection control for faster molding cycles. 3. High-speed clamp action. 4. Precision control of speeds and pressures to insure high molding quality. 5. Must be a "clean" package . . . compact, leak-free, simple to install, fast and easy to maintain, quiet, conserve electrical power.



New "NATCO 400" Plastics Injection Molding Machine — one of four standard sizes. Note overhead position of the Oilgear pump and reservoir . . . away from dirt and molding-room traffic. This position permits fast gravity flow of oil from the reservoir through a prefill valve into the large clamp cylinder to speed operation. During the past year . . . a period of unusually low capital investment purchases . . . over 150 Oilgear Pumps have been put into operation on this new "NATCO" line.

SOLUTION: Cooperation and teamwork between "NATCO" and Oilgear engineers resulted in a new, shockless, *Fluid Power* System . . . basis of a revolutionary new line of high-speed, high-capacity, plastics injection molding machines. This system incorporates two Oilgear Pumps . . . one, a large capacity, radial piston, two-way, variable displacement type "DX" pump with remote electric control which alternately serves the mold clamp and injection rams; and a small capacity, constant displacement type "HG" pump which maintains a high, positive clamping force during injection cycle. Instead of using conventional valves "under pressure" to reverse clamp and injection rams, these functions are accomplished by reversing fluid flow in the Oilgear type "DX" pump. With this system, flow and pressure decelerates to zero *before* flow direction is changed . . . flow then accelerates to a preselected volume in the new direction — completely eliminating reversal shocks. No chokes or other controls on the master valve are necessary, as diverting of flow from clamp to injection rams is also made under ideal "no-flow" conditions, with absolutely no shock. Infinitely variable machine speeds are obtained by varying pump stroke, resulting in a minimum of heating and horsepower dissipation.

For similar practical solutions to YOUR linear or rotary Controlled-Motion problems, call the factory-trained Oilgear Application-Engineer in your vicinity. Or write, stating your specific requirements, directly to . . .

THE OILGEAR COMPANY
Application-Engineered Controlled Motion Systems
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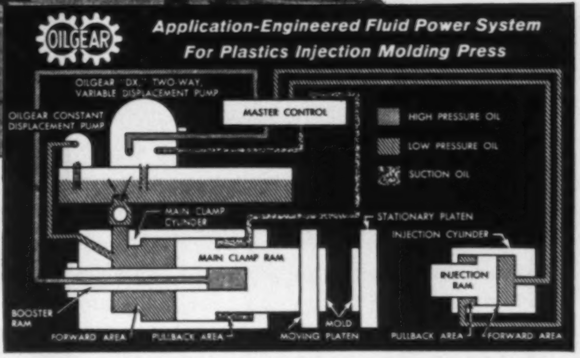
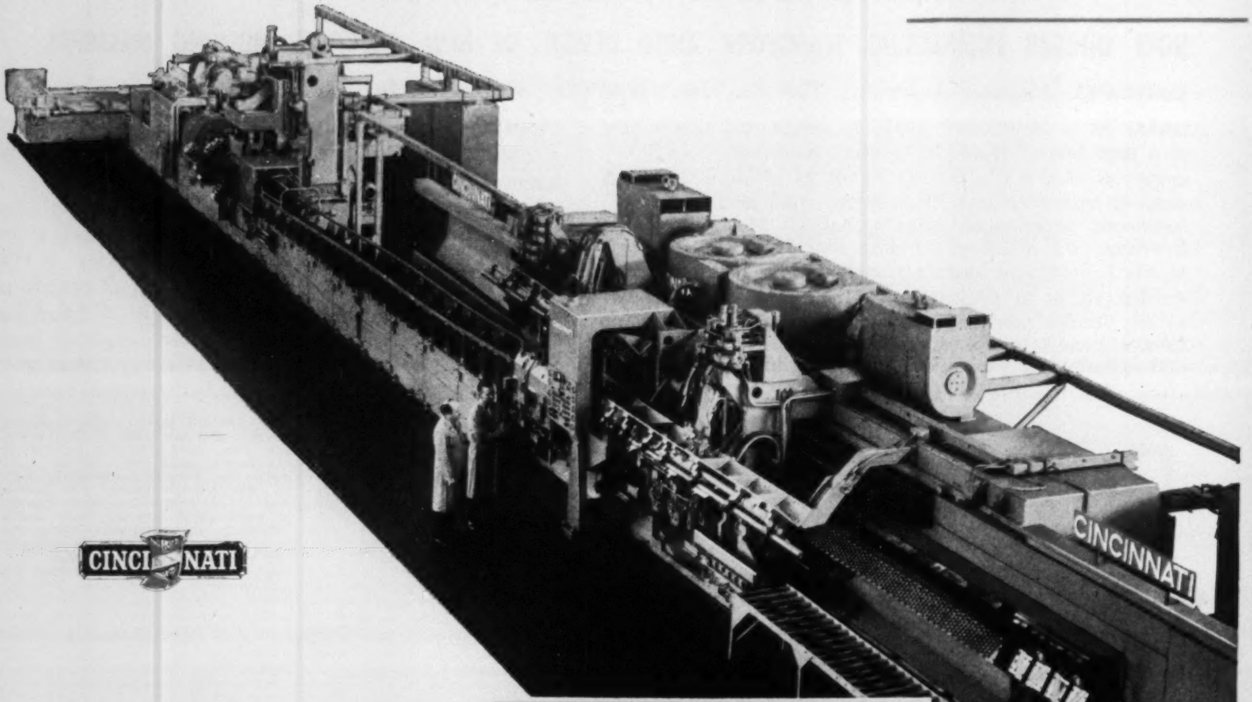


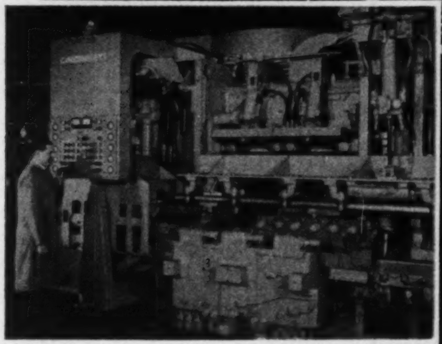
Simplified schematic illustrates one phase of system operation — high-speed closing of clamp ram. Large clamp cylinder is being gravity-filled through prefill valve, while mold clamp is being advanced by small booster cylinder powered by Oilgear "DX" pump. Closing speed — 700 in./min. This circuit design provides clamp pressure build-up in a fraction of a second . . . one of the reasons for the fast cycles on the "NATCO 400."

"NATCO," famous in machine tool and plastic molding machine fields, states — *"Although lower priced pumps could be secured, they basically did not offer the control features found in the Oilgear units. This is especially true of the larger capacity pump, which in addition to its variable and reversible features incorporates many auxiliary controls. It's more than just a pump . . . it contains auxiliary systems for pilot, supercharge, cooling, safety, and filtering. These pumps are quiet. They have an excellent injection molding machine service record . . ."*

CINCINNATI | SPECIAL MACHINE DIVISION



BROACHING STATION. As blocks move through the line, the top, bank faces, pan rail, bearing pads, bearing locks and half bore are broached.



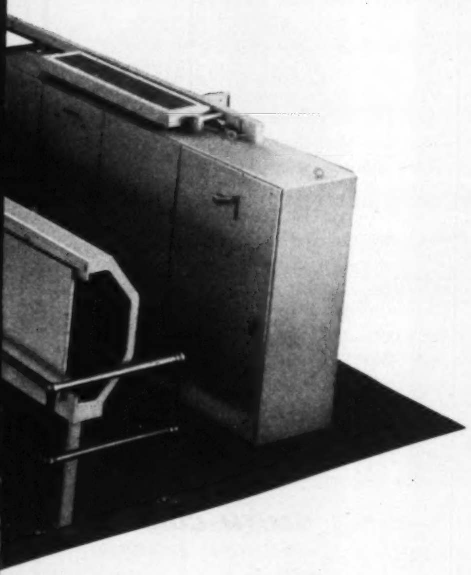
MILLING STATION. Pads are milled on the side of the block, and the front and rear ends are rough and finish milled. Front of block is being milled in this photograph.

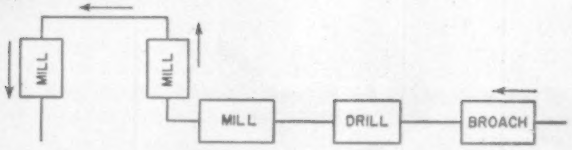
DESIGNERS AND BUILDERS OF SPECIAL MACHINES • HORIZONTAL BROACHING MACHINES •

THE CINCINNATI MILLING MACHINE CO., CINCINNATI 9, OHIO

builds 36-STATION TRANSFER LINE

to automatically machine V-6 *and* V-12 *Engine Blocks*





CINCINNATI 36-STATION TRANSFER LINE broaches, mills, drills and reams V-type engine blocks . . . all in one continuous operation. Production—67 per 60 minute hour.

In this special 36-station transfer line, the world's largest horizontal broaching machine is integrated with drilling and milling stations . . . for continuous, automatic machining of automotive engine blocks. Both V-6 and V-12 blocks, made in three different bore sizes, are accommodated with very little change-over. Cincinnati's Special Machine Division designed, built and assumed full responsibility for every detail of the line.

Twelve surfaces are machined on the broach, which has a 600 hp drive capable of developing a broaching force of 100 tons! Manufacturing holes then are drilled and reamed, and 10 surfaces milled, all in one continuous automatic operation. The line measures approximately 140 feet, and contains 30 motors rated at more than 1000 hp.

From the first broaching operation to the final interlock station, this giant production line is evidence of the capabilities of the Special Machine Division. In addition to over 45 years' experience in designing and building special machinery, Cincinnati offers the most extensive research and development, foundry and shop facilities in the machine tool industry. And you will be pleased with Cincinnati's follow-up service to assure dependability of performance. Our Field Engineers will be glad to give you an analysis of what the Special Machine Division can do for you.

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CINCINNATI®
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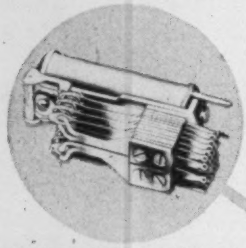

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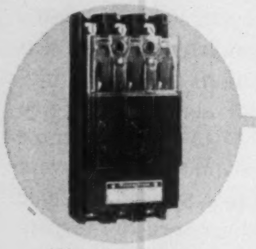

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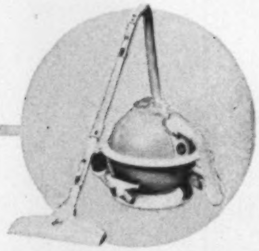

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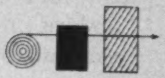
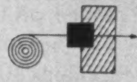
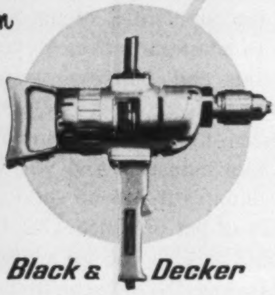


LITTELL STRAIGHTENERS remove coil curvature, send flat stock into the press.



LITTELL ROLL FEEDS push the straightened stock into the die area in perfect timing with the press stroke.



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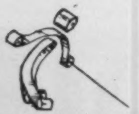

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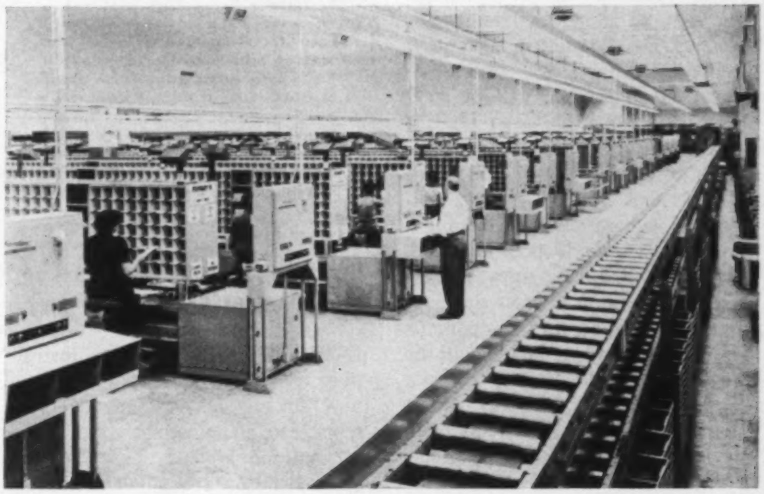
AUTOMATION news

Today's events and developments in the field of automation

Improvements Facilitate Mail Handling in Chicago Post Office



SUPERVISOR is shown at one of the control stations from which he can control the flow of mail to and from the primary sorting area in the huge Chicago post office. By use of these controls, the desired type and quantity of mail is automatically delivered to specified sorting positions.

ONE of the most complete and extensive systems for handling letter mail is to be used at the Chicago Post Office. This post office, the largest under one roof, acts as a gateway to both the East and the West, and handles more mail in a day than does any single European country.

Because of this volume, an extensive system for faster handling of letter and flat mail has been installed. A conveyor system automatically routes and transports all first class letters and circular mail handled on four floors of the post office. This system uses over 20 miles of various types of conveyors, over 2000 motors, approximately 5000 relay logic functions, and over 1000 pneumatically operated control devices. System is designed so that trains of mail trays are automatically directed to the proper station requesting that particular type of mail; individual trays are selectively directed to their proper destination, with points of converging conveyors controlled so that trays do not jam into each other; vast overhead storage systems are maintained on a first-in, first-out basis with individual systems required for first class and circular mail, zoned and unzoned local mail, and primary and secondary sorted mail. Because of the numerous potential jam points in the conveyor network, a series of signal lights are provided to indicate when it is necessary to divert the flow of mail into another loop in the system. The conveyor control system was designed, manufactured, and installed by Industrial Nucleonics Corp.

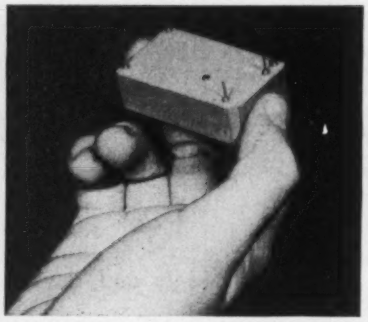
Mail for local delivery is received and put into trays on conveyors. At this point, it is sorted into first class or circular, zoned or unzoned classifications, then dispatched to one of three primary sorting areas or to overhead storage conveyors. In the primary area, mail is separated into the appropriate zones for the city of Chicago. Mail for individual zones is placed in a pre-coded tray, which is automatically routed to the appropriate secondary sorting line, where it is further separated for substations or carrier routes. The mail is then pouched by carrier route and sent to various substations for further separation by the letter carriers.

Out of town mail is also received and put into trays on conveyors, but these trays are coded differently than local mail. Two vertical lift conveyors carry the trays to the ninth floor, where a primary sort is made, separating the mail into various states or large cities. Inclined belt conveyors carry this mail down to the eighth floor where, in the secondary distribution point, it is further separated into various cities within an individual state. In many instances, this mail will first be directed into overhead storage lines where the mail trays are individually separated according to their secondary destination, and from which they are individually requested by their respective secondary work station.

Other developments and improvements used in this post office are: Culling machines which mechanically separate the letter mail from small packages of flats and prepare it for facing-cancelling machines which electronically arrange and cancel stamped mail; letter sorting machines which separate letters by destination into 300 bins according to code-punched instruction from their operators, and parcel post sorting machines which distribute parcels according to operator's instructions.

Detroit is the Scene of Design Engineering Show

THE DESIGN ENGINEERING SHOW, which takes place May 22 through 25, will be held for the first time in Detroit. The show is produced by Clapp & Poliak Inc. with a concurrent conference sponsored by the Machine Design Division of the American Society of Mechanical Engineers. The exposition and conference will be held in the newly-opened Cobo Hall, a five-acre building designed virtually free of columns or pillars. Both the show and conference are devoted to the research and development aspects of new products of all types. More than 400 companies are expected to exhibit. Latest developments in materials and components for manufactured products will be shown. Show hours will be from noon to 5:30 pm each day except Tuesday when it will remain open until 10 pm. The opening conference session will be a panel spotlighting design engineering in the automotive field. The succeeding three days of the conference will be devoted to specific design problems.



CORE-TRANSISTOR counter, developed by Sprague Electric Co., is capable of speeds to 10 kc, provides an output signal for every 10 input pulses, then resets in preparation for the next cycle. The general circuit configuration consists of a quantizer, a transfer loop, and a counter circuit. Counting is achieved by the progressive reversal of the counter core flux in discrete steps where each flux change is determined by the voltage integral from the quantizing circuit.

Institute to Study Management Science

ESTABLISHMENT of an institution for study and application of new techniques in management science to management control and information systems, has been announced by Operations Research Inc., a research and technical planning firm. The new institution, called the Institute for Management Dynamics, is composed of three centers—a research center, a management center, and a system training center. The staff will include people trained in physics, electrical and mechanical engineering, computer sciences, economics, psychology, mathematics, statistics, and industrial engineering. Scientific approaches to business management, production control, and complex weapons system integration will be studied, applied, and developed.

Organizes Automation Activities in One Group

PLANS have been announced by General Electric Co. to join in one organization all of its market development and advanced engineering activities for the automation of industrial processes. The new group will be called the Systems Sales and Engineering Operation, and will be headed by **George W. Knapp** as manager. Headquarters will be in Schenectady.

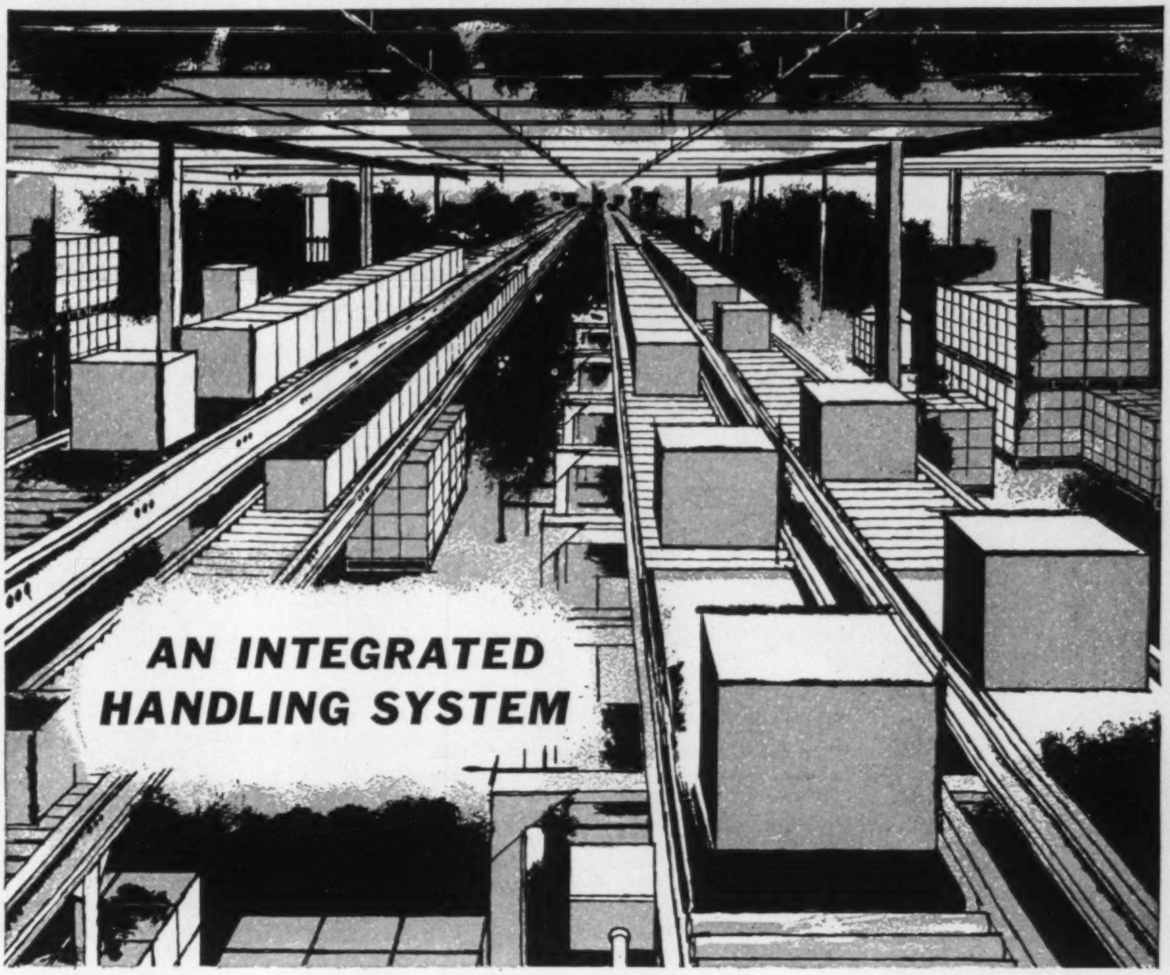
The central activity will draw on products manufactured in some 40 different company locations. The operation will perform systems work for the entire range of industrial customers such as heavy industries, process industries, and machinery manufacturers. Services include: Data processing, mathe-

Magnetic Cards Provide Random Access Memory

MEMORY FILE, developed by National Cash Register Co. for use with its 315 electronic data processing system, employs a removable cartridge containing 256 magnetic cards on which information can be stored in any order and selected and read when required in a sixth of a second. With this system, it is also possible to store, sort, update, and report through use of a single magnetic file.

The plastic cards used with the system are suspended from 8 rods in a removable cartridge. Each rod may be independently rotated to either of two positions. By rotating the rods to selected positions, a desired card is released onto a rotating drum where it is read or written on at a rate of 100,000 alpha-numeric characters a second. Information is magnetically recorded on one of seven vertical tracks on the card. The computer selects the recording track for reading or writing data. There are 256 cards in each cartridge and each card can store 21,700 alpha-numeric characters or 32,550 decimal digits of information, providing a storage capacity of over 5.5 million alphanumeric characters or 8.3 million digits in a single cartridge.

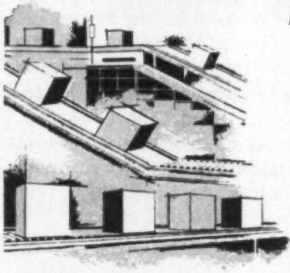
The computer system can operate up to 16 cartridge file units and can control up to eight multispeed magnetic tape units. Cartridges of magnetic cards are interchangeable between units. Another feature of the memory file is its ability to store or transfer data in either a random or sequential manner. In random storage, any card can be selected in 170 milliseconds; re-access of a card already in the write-read station is only 14 milliseconds. When used as a sequential storage medium, one magnetic card unit can efficiently perform difficult sorting tasks. A full sort with two-way merge capabilities can be performed for up to 69,440 ten-word items on a single unit.



Overhead conveyor system saves thousands of square feet of floor space.

...Engineered by ALVEY...

May Cut Your Package Handling Costs

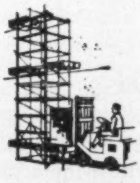


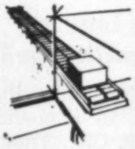
It doesn't pay to buy conveyors piecemeal. You don't have to throw away your present equipment and start from scratch, either.

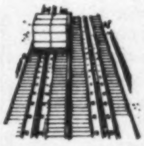
Alvey's experienced package handling engineers can show you how to coordinate the workable parts of your present system with new elements for faster, easier, less expensive materials handling.

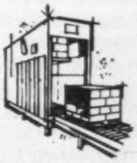
Or, they can build a complete system for a new plant, or total modernization program.

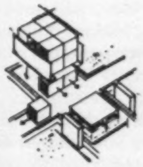
Remember, it's often more profitable to cut processing and handling costs than to make new sales. Call in Alvey, and reappraise your handling methods now.

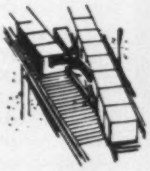

Vertical Lift Conveyors

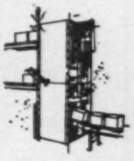

Telescopic Boom Conveyors


Air-Chain Conveyors


Pallet Loaders


De-Palletizers

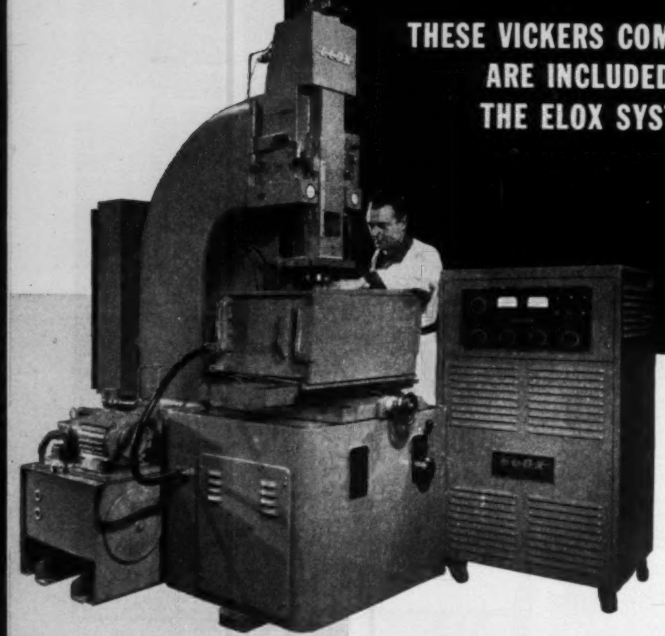

Traffic Cop


Vertical Indexing Conveyors

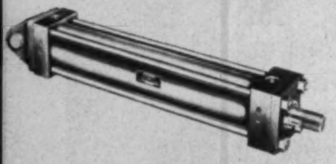
ALVEY CONVEYOR MANUFACTURING COMPANY

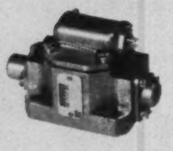
9373 Olive Street Road, St. Louis 32, Mo. • *Branch Offices in Principal Cities*

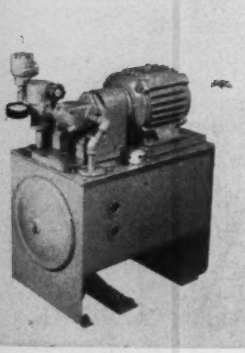
Circle 658 on Page 35



THESE VICKERS COMPONENTS
ARE INCLUDED IN
THE ELOX SYSTEM







HYDRAULIC CYLINDERS—Low frictional drag and dependable operation of the 3-inch bore, 12-inch stroke cylinders makes them ideal for the Elox machine shown. Vickers builds a complete line of cylinders and offers a wide choice of mounting options, rod end threads, wrench flats, port positions and connections. Standard bore sizes range from 1½" to 8" with either standard or heavy duty rods; special designs can be provided to suit every application. For more details ask for Bulletin 60-68.

SERVO VALVES—Extremely critical requirements for low deadband and high response for instantaneous reversals to clear the electrode dictated the selection of a Vickers servo valve for the Elox spark discharge machine. Three series of Vickers servo valves are available to meet every type of industrial application: a single stage valve rated at 0-3 gpm and two series of 2-stage servo valves for flows of 0-17 gpm and 0-37 gpm. For more details ask for Bulletins 59-74, 61-79.

POWER PACKAGE—The standard Vickers T-10 power package supplies the steady pressure required for optimum operation of the Elox electrical discharge machine. A vane pump and relief valve matched to the system plus the basic tank unit constitute the power package. Vickers builds the most complete range of power packages available anywhere—all components "matched" in output to insure optimum performance and reliability. For more data on how these power packages can simplify your design and procurement problems, contact your Vickers Application Engineer.

Don't Miss Booth 549
Design Engineering Show
Detroit, May 22-25

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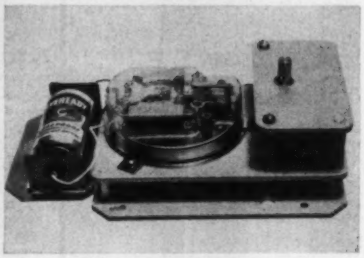
VICKERS®

VICKERS INCORPORATED
DIVISION OF SPERRY RAND CORPORATION
Machinery Hydraulics Division
ADMINISTRATIVE and ENGINEERING CENTER
Department 1536 • Detroit 32, Michigan



CHRONOMETRICALLY governed dc motors are currently used in a chart drive with a timing cycle of 192 hours. The motors, designed by A. W. Haydon Co., can be operated for more than two years on a standard flashlight battery. They can be used for applications requiring high accuracy and low current drain, as for example, operating contacts, cams, and actuators where loads are larger and vary over greater limits than escapement type drives can handle. When used as a clock drive, a constant speed of 150 rpm is maintained by the governor's patented balance wheel-hair spring mechanism, with an accuracy of ±10 seconds in 24 hours, which is an accuracy of 1/50th of 1 per cent.

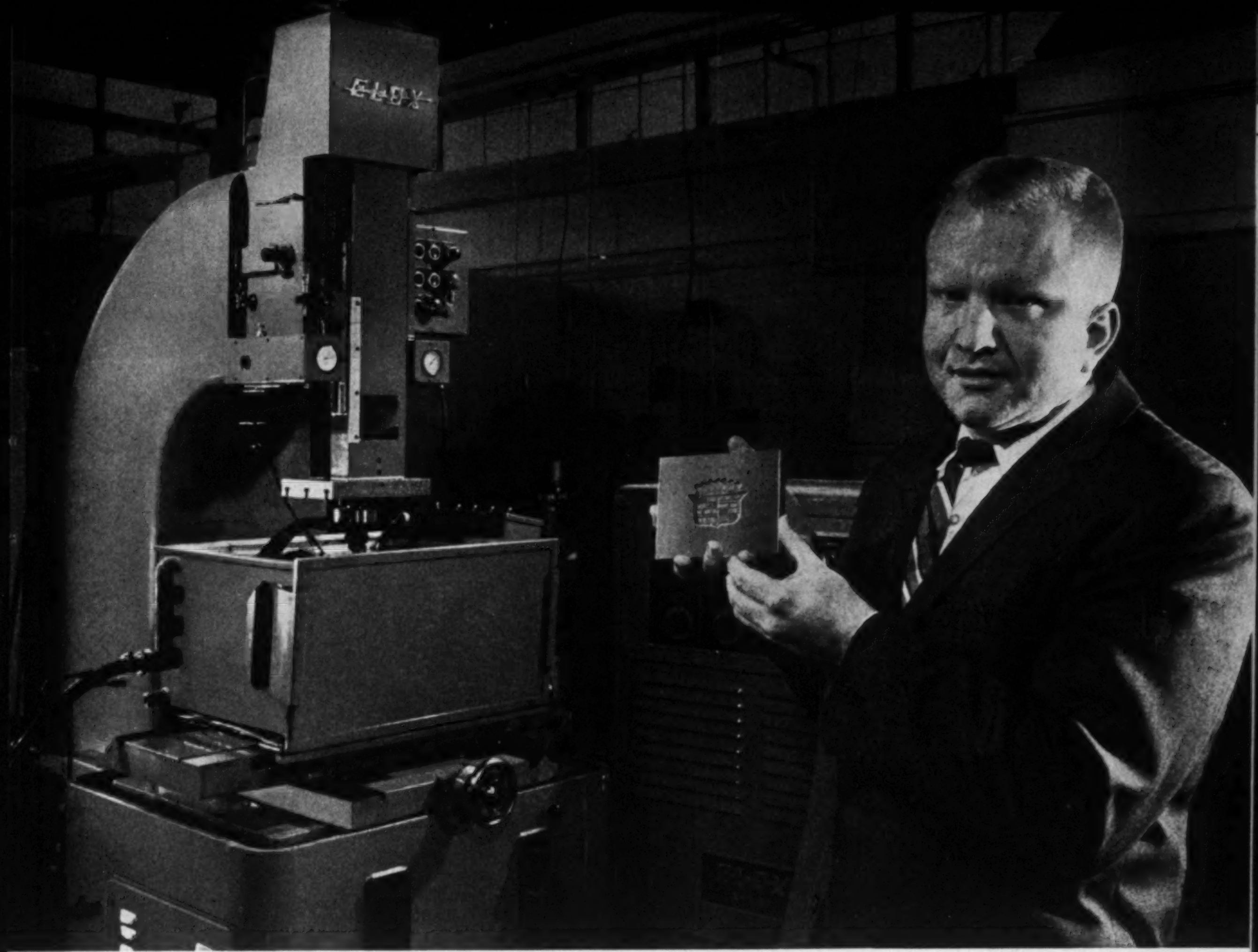
matical simulation, control and instrumentation engineering, power conversion and distribution, and drive system engineering.

Another phase of activity for the new group will be the establishing of an advanced computer center for simulation experiments to solve process problems and to develop new systems techniques.

SUBSTATION automatic printing ammeter has been designed by Lundell & Co. to transmit information from a remote substation to a central load dispatcher. Information regarding line amperes and other variables is collected and coded to a teletype signal. The signal is transmitted either over telegraph or telephone wires. At the central point, the signal is decoded and the information printed on a Teletype page printer.

New Entry in Magnetic Tape Field

ENTRY into the magnetic tape field is announced by Eastman Kodak Co. They will manufacture and sell tape packaged in rolls ¼-inch wide in standard lengths for professional and amateur sound recording uses. **M. Wren Gabel**, vice president and general manager of



ROBERT WEBB, RESEARCH DIRECTOR, ELOX CORPORATION SAYS:

"Jointly developed hydraulic system provides fast response needed for spark machining . . ."

"When people have a problem that can be solved with three-dimensional electric discharge machining, they come to Elox for our special skills and knowledge. Similarly, we insure that our machines offer the last word in performance by working as a team with components and systems manufacturers.

"To produce cavity dies like the one shown above, we designed and built a machine with a precision table and a vertical slide accuracy that we can guarantee within .0005" to 12 inches. We were able to develop a hydraulic circuit for the vertical slide and get a faster response than with any other method because Vickers engineers understood our problems thoroughly and cooperated fully in effecting their solution.

"Speed of response is half the story; the other is precise maintenance of the spark gap without 'hunting'—enabling the spark machining operation to be completed in the shortest possible cycle. Our hydraulic package meets all the foregoing requirements because the individual units are matched to each other and to the machine itself."

The Elox experience is typical of Vickers assistance to machinery builders and/or users in providing outstanding hydraulic equipment or systems to insure peak performance. Specialists working with the broadest line of top quality hydraulic components available anywhere give you a system ideally suited to your specific needs. See facing page for more details about the hydraulic components used by Elox and the entire Vickers line.

VICKERS®

VICKERS INCORPORATED
DIVISION OF SPERRY RAND CORPORATION
Machinery Hydraulics Division
ADMINISTRATIVE and ENGINEERING CENTER
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9640

WEBB
TOWMATIC
1 2 3 4 5 6 7 8 9 10

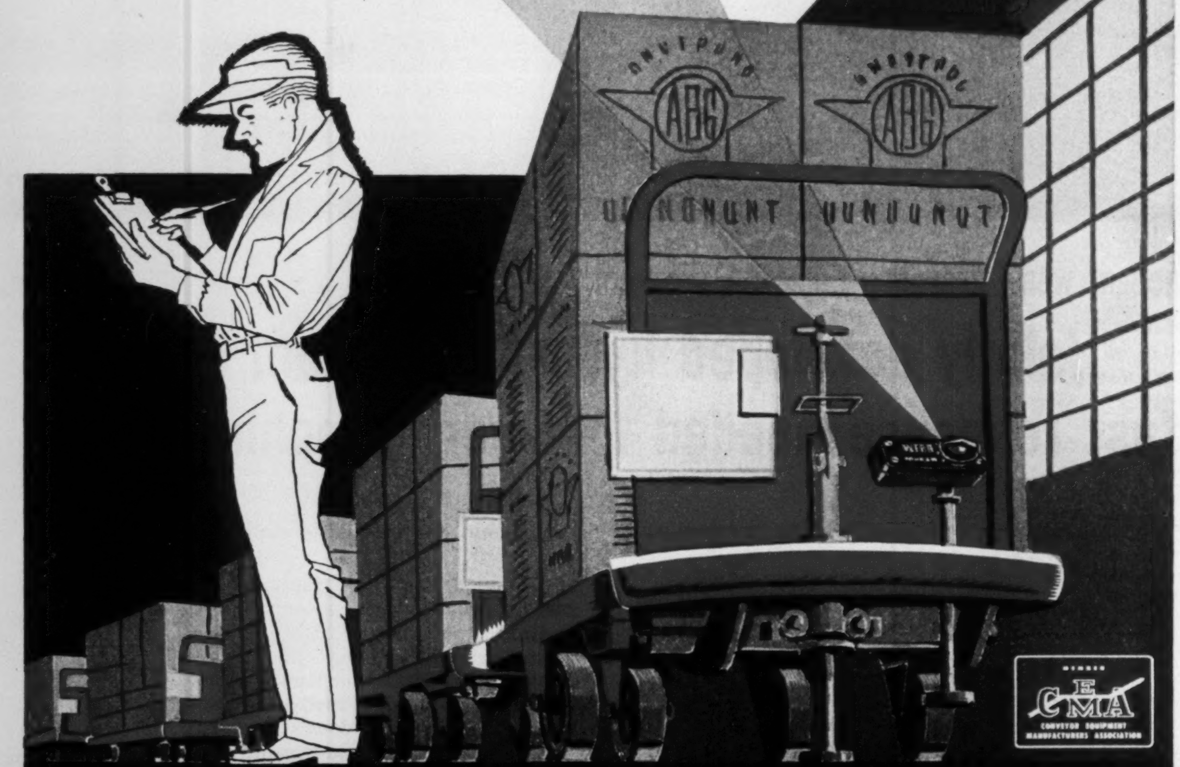
Set the dial and let 'em roll!

FROM RECEIVING TO PRODUCTION TO SHIPPING . . . VIA *TOWMATIC!!

AUTOMATIC SWITCHING TOWVEYORS? We custom-make them to fit your exact specifications . . . from small detachable selector units offering up to six dispatching points, to large elaborate units offering up to 100 different dispatching points! We call it TOWMATIC. Since its inception, several years ago, Webb has installed *more* automatic switching towveyors *than any other manufacturer.*

TOWMATIC, the latest innovation in Towveyors, allows the cart to travel from any station to any other predetermined station on the power loop. The carts can be placed or removed from the power loop at any point by raising or lowering the tow-pin. *It is never necessary to wait for power!* The carts can be engaged at any position on the loop and are immediately on their way! Results? Materials are automatically moved from one area of the plant or warehouse to any other area . . . with no personal escort!

Towveyor installations are custom-made to suit the specific layout for which it is intended. So, whether you are operating out of a two-car garage, or a million square foot establishment, it will pay you to investigate the possibilities of Towmatic. Call a Webb Engineer today . . . he'll show you how to increase your profits through efficient materials handling methods.



MEMBER
CEMA
CONVEYOR EQUIPMENT MANUFACTURERS ASSOCIATION

*REGISTERED TRADE NAME

WEBB

SPECIALISTS IN CUSTOM CONVEYOR SYSTEMS
JERVIS B. WEBB COMPANY
8951 ALPINE AVENUE • DETROIT 4, MICHIGAN
OFFICES IN ALL PRINCIPAL CITIES

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Kodak said that the company's long experience with film manufacturing technology affords it a good background for the production of quality tape. Research scientists at Kodak are continuing their investigation of a complete range of magnetic tapes for varied applications such as instrument recording and electronic computing.

MAGNETIC THIN FILMS less than 40 one-billionths of an inch thick, only 1/75,000th the diameter of a human hair, have been produced by scientists at the Research Center of Minneapolis-Honeywell Regulator Co. The company said it has achieved speeds of billionths of a second with its thin films and currently is designing hardware for special-purpose airborne computers using thin film memories.

Trade-In Plan on Machine Tools Initiated

MACHINERY TRADE-IN plan has been announced by Pratt & Whitney Co. Inc. Used or surplus machine tools of any manufacture will be accepted as part payment or for credit toward the purchase of new Pratt & Whitney products. An organization, named the Machinery Trading Corp., has been established to handle these trade-ins.

This separate corporate unit will have all the facilities to properly warehouse, recondition, and sell the machines taken in trade. It will also actively engage in the used machinery field, by purchasing for its own stock, surplus machinery of all descriptions, specializing in equipment of Pratt & Whitney manufacture.

Pressure Die Cutting Eliminates Impact

NOISE AND VIBRATION caused in manufacturing operations where fabrics or other sheet stock must be cut in volume, has been reduced with the development of a die cutting machine which depends on pressure rather than impact. The machine, designed by United Shoe Machinery Corp., uses a hydraulic-electronic principle to press a die

Computers Begin Telephone Billing Operation

INAUGURATION of an electronic data processing center to take care of accounts for 300,000 telephone subscribers has been made by the Bell Telephone Co. of Pennsylvania in Conshohocken, Pa. The EDP center will handle all billing and collection information for subscribers in the suburban Philadelphia area. In an average day, the computer will rate 300,000 calls, prepare 15,000 bills, post 15,000 payments, review and update 300,000 accounts, and report a variety of statistical information. Similar installations are expected throughout the Bell System in coming years.

Central unit of the installation is an IBM 7070 digital computer. It is a transistorized, expandable modular system, augmented with auxiliary components to form a tape-oriented configuration. Two satellite IBM 1401 computer systems are provided for input-output conversion operations. The large computer will read 62,500 magnetic tape characters per second, and has a magnetic core storage capacity of 100,000 decimal digits. Recall of stored data requires six microseconds per digit.

IBM 7070 SYSTEM

Heart of the electronic data processing center is this computer room—first in the Bell System for billing and collecting. After information is compiled, the data is fed to a printing machine which turns out nearly 100 bills a minute.

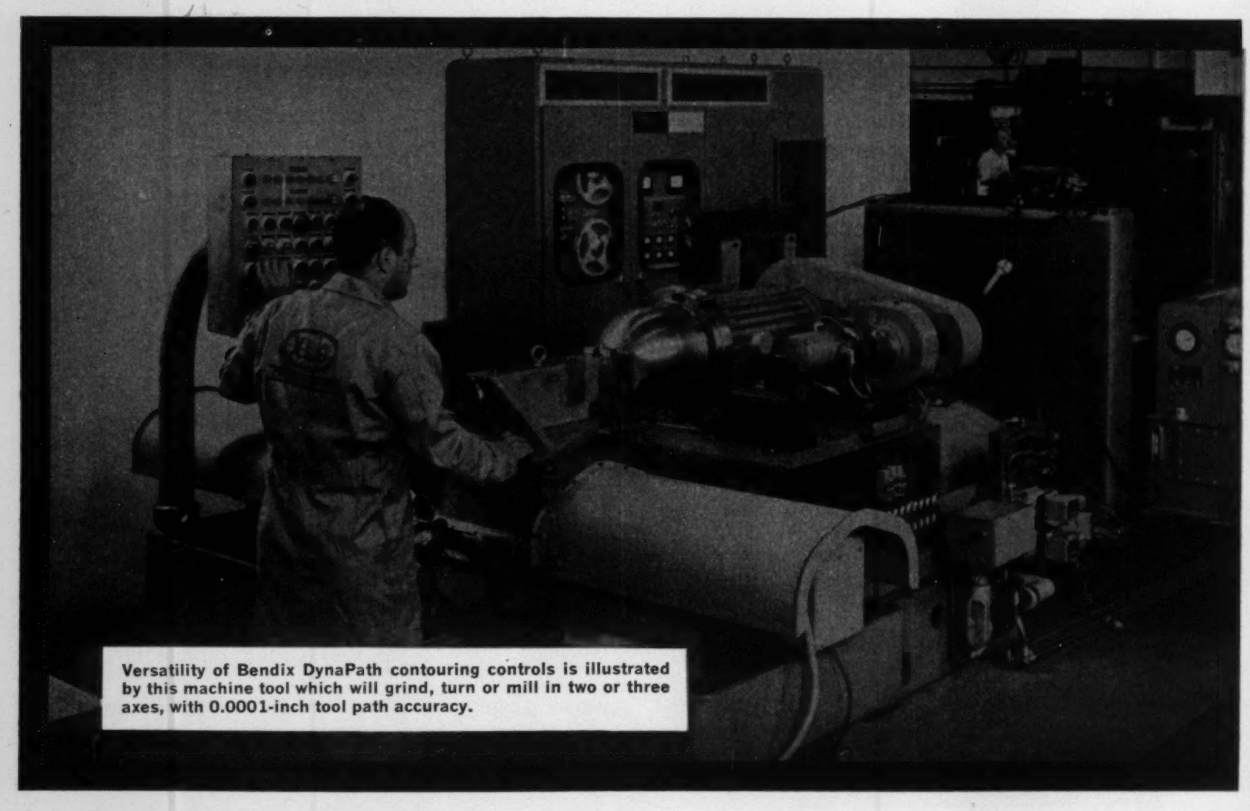
The system includes special units which convert central office records from automatic message accounting tape to magnetic tape and translate information from teletype tape, mark-sense cards, and punched cards to magnetic tape. Tape handling features of the system include four speeds of tape operation, high-speed rewind, tape compression through high-order zero elimination, and automatic alphameric or numerical mode selection.

Data on customers, such as name and address, equipment itemization, deposit records, coin-telephone information, directory delivery addresses, and credit data are stored on magnetic tape. Charges, credits, and other appropriate information are posted to the tapes daily. The computer identifies unpaid accounts and produces reminder notices or colection notifications. It also reviews credit ratings, analyzes deposit records, prepares refund checks, and performs similar routine tasks.

Future applications are expected to include: Payroll processing, property and cost accounting, planning construction programs, and compiling personnel statistics.

BENDIX PROVIDES SYSTEMS EXPERIENCE TO MAKE NUMERICAL CONTROL WORK FOR YOU

Numerical control is a proved concept in metalworking. It has demonstrated its worth in scores of applications, but perhaps your manufacturing problems are different. Why not enlist the services of Bendix—long-time supplier of practical, reliable numerical control systems to most major machine tool builders. Let us be your prime source of information and assistance when the demand for increased productivity indicates a need for more modern equipment that will reduce scrap, reduce lead time, reduce inventory costs, and reduce tooling costs. Whether it's contouring, positioning or measuring, Bendix has the solution to your particular problem.



Versatility of Bendix DynaPath contouring controls is illustrated by this machine tool which will grind, turn or mill in two or three axes, with 0.0001-inch tool path accuracy.

YOU NEED BENDIX SYSTEMS EXPERIENCE when you consider numerical control for your application! Bendix offers:

1 **JUSTIFICATION STUDIES**—what can numerical control do for you?

2 **SYSTEM ENGINEERING**—applying the right control to the right machine tool.

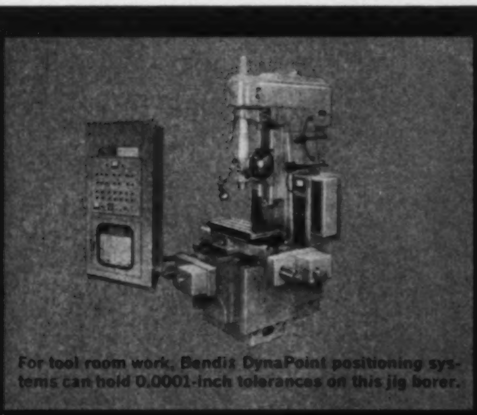
3 **TRAINING AND SERVICE**—for maximum machine utilization rates.

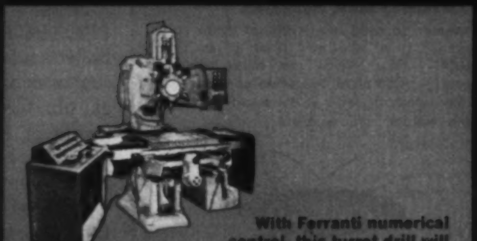
The unique Bendix Systems Experience is backed up by a staff of experienced electronic, mechanical and hydraulic engineers, mathematicians, instructors, technicians, and parts planners. Our contract machining and tape-making facilities offer years of accumulated case histories on all manner of applications *and* a chance to check out *your* problems in actual practice. Why not write today for more information on Bendix Systems Experience.

Industrial Controls Section
21820 Wyoming Ave., Detroit 37, Michigan

THE Bendix CORPORATION

Bendix
SYSTEMS EXPERIENCE


For tool room work, Bendix DynaPoint positioning systems can hold 0.0001-inch tolerances on this jig borer.


With Ferranti numerical control, this turret drill will do the work of several conventional machines, and reduce scrap.

another triumph in automation

AMECO

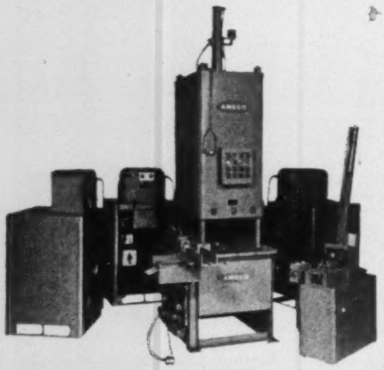
AUTOMATIC STACK HEIGHT SELECTOR

Accurate to within one lamination

AMECO's new selector speeds the laminate stacking operation by 2½ times. Turns out over 500 per hour with constant accuracy.

AMECO STACK HEIGHT SELECTOR

- Measures pre-set stack height within plus or minus one lamination.
- Handles up to 4" dia. lamination and up to 2" max. height of stack.
- Accepts lamination even with excessive burrs.
- Changes over easily for different sizes.



STATOR PACK WELDER

Designed to weld sub-fractional stator cores from 2" to 4" dia. and from ½" to 2" in height. Four welds are made simultaneously. Complete operation can be made fully automatic with some modifications to both welder and measurer.

AMECO

AUTOMATION MACHINES & EQUIPMENT CO., INC.
3130 W. Mill Rd. Milwaukee 9, Wisconsin
FLagstone 2-7250

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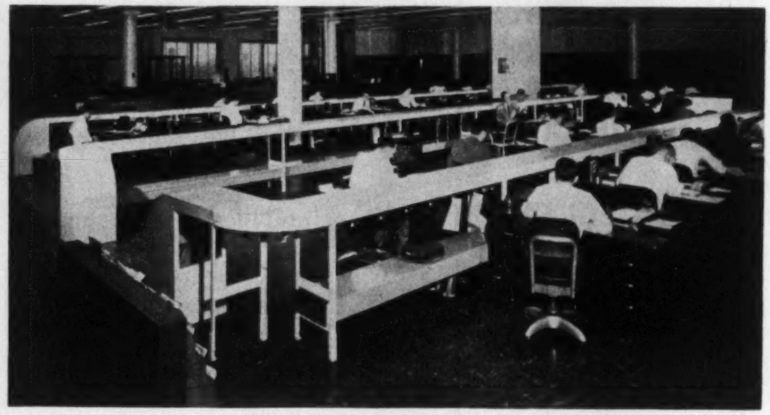

CONVEYOR SYSTEM is used to handle paperwork in the general order department of Joseph T. Ryerson & Son Inc. in Chicago. The firm operates a service center there for the processing and sale of steel, aluminum, industrial plastics, and metal fabricating machinery. The conveyor, manufactured by Chainveyor Corp., is used to move orders, mail, internal correspondence, files, and other lightweight material from desk to desk, room to room, and floor to floor in the company's 5-story office building, with loading and unloading accomplished at predesignated stations. System travels both horizontally and vertically and makes 180 degree turns within a 2-foot radius. A release mechanism on the carrier automatically drops papers at appointed places, as determined by an established color code which identifies the carrier and its unloading station.

through fabric, leather, rubber, and similar materials. Since there is no impact, there is never any noise or jarring. With the electronic control, only the exact amount of pressure required to press the die through the material is exerted, and the pressure is released the instant the die touches the conductive cutting surface.

In operation, a die is placed on material laid on the cutting surface (in single sheets or multiple layers), the beam is positioned at any point over the cutting surface, and the pressure mechanism is triggered. Cutting surfaces of the machine are aluminum or a special conductive material which forms parts of the circuitry for the release of pressure when the cut has been completed.

Instrument Detects Sugar Contamination

PROTECTION of a $5 million boiler and turbine installation from sugar contamination is performed at the Crockett Refinery of California at Hawaiian Sugar Refining Corp. by an analytical instrumentation system called an AutoAnalyzer. Developed by Technicon Controls Inc., the system automatically monitors returning condensate for sucrose traces from 0 to 80 ppm. With this method, the boiler installation is guarded against the damage which would result if appreciable quantities of sugar entered the boiler along with the returned condensate. A chart recorder automatically graphs the readings.

ASTME Show to Use New York Coliseum

HIGHLIGHT of the 1961 convention, sponsored by the American Society of Tool and Manufacturing Engineers, will be an exposition of creative manufacturing equipment. The engineering convention and exposition will be held May 22 through 26, at the New York Coliseum in New York City. Around 400 exhibitors are expected to participate in the event. New processes and techniques will be studied to give the manufacturing engineer an over-all picture of industrial progress. A two-day seminar on surface metrology, technical tours on numerical control and high energy rate forming, and a material removal symposium are scheduled on the program.

SERVICE for companies that want to sponsor engineering scholarships but do not have scholarship administrative facilities has been initiated by the Hertz Engineering Scholarship Foundation. With this service,

Quality metal products deserve

"the finishing touch" of Mahon

another
example . . .
fine office
furniture
from
General Fireproofing

below: one of GF's new 1000 Series desks, part of a striking, new functionally designed business furniture line. At right: a stage of the complete finishing system designed and built by Mahon for GF's San Luis Obispo, Calif. plant.

Production finishing is the application of coatings of a specified quality at highest efficiency .That also sums up the business of Mahon's Industrial Equipment Division and they have learned it well . . . for over forty years . . . in hundreds of installations . . . for all types of finishing. Mahon metal-cleaning and metal-finishing systems will prove your best investment regardless of initial cost. In this highly specialized, multi-process area, can you afford less than the best for your quality products? Find out how Mahon's 'finishing touch' can improve your products . . . your costs . . . your sales. Call in Mahon.

WRITE FOR MAHON CATALOG A-660
ALSO IN SWEET'S P. E. FILE

MAHON
INDUSTRIAL
EQUIPMENT

- Finishing Systems
- Metal Cleaning Equipment
- Painting Facilities—
  spray, dip and flo-coaters
- Drying and Processing Ovens
- Special Plant and
  Production Equipment

YOUR BIGGEST VALUE IS IN MAHON'S PLANNING & ENGINEERING EXPERIENCE

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MANUFACTURING PLANTS—Detroit, Michigan and Torrance, California
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Chicago, San Francisco and Torrance.

MAHON

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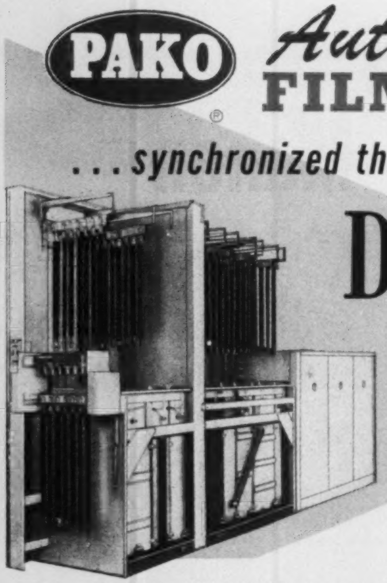
PAKO® *Automatic* FILMACHINES

. . . synchronized throughout by

DIAMOND ROLLER CHAINS



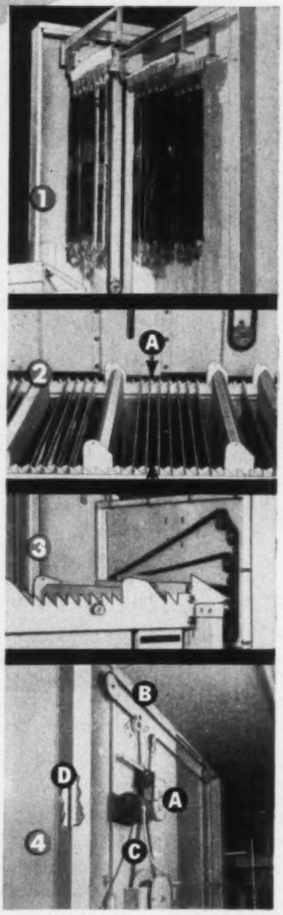
specified for accuracy and uniform high quality!

① On exact, predetermined time schedule, DIAMOND Chain powered transfer arms on elevator bar shift film hangers to next processing tank.

② DIAMOND Chain powered "saw-tooth" tracks (A) move hangers at precisely one tooth per minute.

③ DIAMOND Chain synchronizes film dryer with processor; delivers a hanger of dry film each minute.

④ Rear of PAKO Automatic Filmachine shows speed reducer (A), DIAMOND Chain transfer arm drive (B) and "saw-tooth" drive (C). Counterweights slung from DIAMOND Roller Chain (D) help insure smooth elevator bar operation.



PAKO Automatic Filmachines, manufactured by the PAKO Corporation of Minneapolis, Minnesota, process and dry up to 420 rolls of black and white film per hour. Color machines handle up to 300 rolls per hour. All units are equipped with DIAMOND Roller Chain.

DIAMOND Chain offers many opportunities to solve timing, conveying, and power transmission problems. Call your DIAMOND Distributor or write direct to DIAMOND CHAIN COMPANY, INC., *A Subsidiary of American Steel Foundries*, 402 Kentucky Avenue, Indianapolis 7, Indiana. Dept. No. 412

Offices and Distributors in All Principal Cities

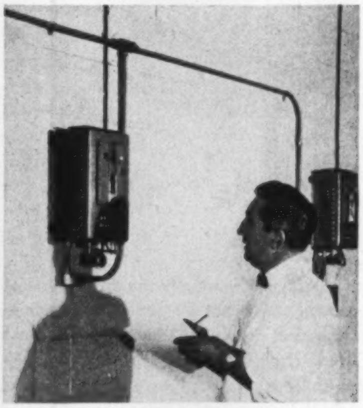
DIAMOND ROLLER CHAINS®

Circle 665 on Page 35

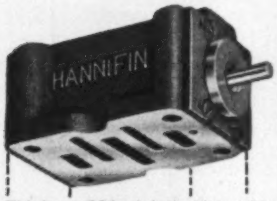
for which there is no charge, if a company wants to offer a $1,000 scholarship, all the money will be applied directly to student aid. In addition to supplying the administrative machinery for scholarship funds provided by others, the Foundation also grants its own scholarships to deserving students.

SPOTLIGHTING PEOPLE

William F. Bohannan appointed manager of the Marysville, Ohio plant of Denison Engineering Div., American Brake Shoe Co. . . . **George W. Smith Jr.** appointed general manager of the Industrial Products Div., Westinghouse Air Brake Co. . . . **Raymond C. Berendsen** named general manager of the industrial process control computer section for the Industry Control Dept., General Electric Co. . . . **Charles F. Claughsey** appointed consultant to the executive vice president for Emhart Mfg. Co. . . . **Meyer Leifer** named chief engineer of the Ampex Instrumentation Products Co. . : . **Zeke R. Smith** appointed executive vice president and general manager of Potter & Brumfield, Div., American Machine & Foundry Co. . . . **Ralph L. Shapcott** named director of manufactur-

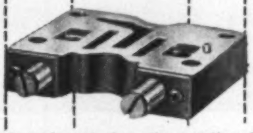


EXPLOSIVE ALARM, made by Mine Safety Appliances Co., is used in aerosol packaging processes. Because the use of butane propellant, without proper precautions, could result in unsafe concentrations of combustible gas, the alarm is designed to halt all equipment and close a motorized supply valve if the concentration of gas reaches 25 per cent of the lower explosive limit. The gas detecting units are also used to indicate leakage from finished products while they are passed through a hot water immersion test tank.



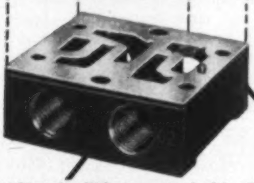
This basic CC body is the "heart" of every CC valve. Its one moving part is the "spool poppet", a Hannifin exclusive that seals bubble tight at either end of its short stroke. Note the ample air passages—all ¼" IPS or larger. This is single-actuator, spring return version.

This is the same body with double-end "spool poppet"—used when two actuators are required.

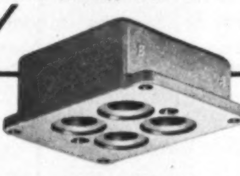


Speed control section, optional—designed to restrict exhaust flow, only, through either or both cylinder ports. Flow to the cylinder remains completely unrestricted through either port.

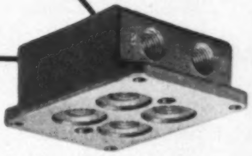
For foot-operated valves, the actuator is also the base, and this rear-ported adapter is used. Available tapped either ¼" or ⅜" IPS.



"Standard" base—used with all but foot-operated models. Every CC base is available tapped either ¼" or ⅜" IPS.



Optional base for "O" ring gasket mounting. Supplied complete with 4 O-rings.



"Universal" base, tapped from beneath and from both sides. Four pipe plugs supplied. Can also be used with O-rings.

THESE QUICK-RESPONSE 4-WAY VALVES MOVE AIR DOWN THE LINE—FAST!

Hannifin CC valve design is the reason. Short, positive strokes of the "spool poppet" open up instant and ample passages for air.

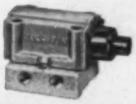
Actuation? Any way you want it!

One basic body with a wide selection of operating heads and bases—all with or without our new speed control section—give you over 3,000 choices. We can help you make the right choice . . . through our field engineering service. Call your nearest Parker-Hannifin office or write us direct for full information.

SINGLE ACTUATORS

(Spring Return)

Solenoid



Pressure

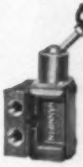
Roller Cam

Ball Cam

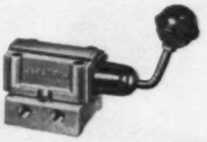
Over-Riding Cam

Toggle

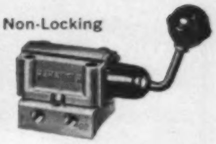
FIVE HAND VALVES



Locking



Non-Locking



TWO FOOT VALVES

Locking

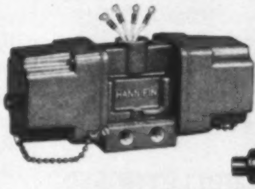
Non-Locking

TYPICAL COMBINATIONS

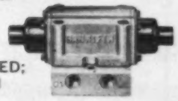
(Hundreds Available)

FOOT-OPERATED, LOCKING;
PRESSURE OVER-RIDE
—used on foundry machinery

CAM-OPERATED;
PRESSURE-RETURN
—used on automatic wash tanks



DOUBLE SOLENOID
—used everywhere



PRESSURE-OPERATED;
PRESSURE-RETURN
—used everywhere

PARKER HANNIFIN CORPORATION

HANNIFIN COMPANY
A DIVISION
541 South Wolf Road • Des Plaines, Illinois
PNEUMATIC AND HYDRAULIC SYSTEM COMPONENTS
EUROPEAN DIVISION • PARKER-HANNIFIN N.V. • SCHIPHOL • THE NETHERLANDS

3138 PH.

Circle 666 on Page 35

SPHERCO®
BEARINGS

SPHERCO ® USA
AVAILABLE WITH SINTERED BALLS

If you have applications involving linkage or transfer of motion, SPHERCO Bearings can supply your needs in a wide variety of materials with a quality that will give you top performance under normal or high temperature conditions.

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SBG Series
TR-N TR Series
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Forged One-Piece Control Link

WRITE FOR BULLETIN 560

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A PRODUCT OF
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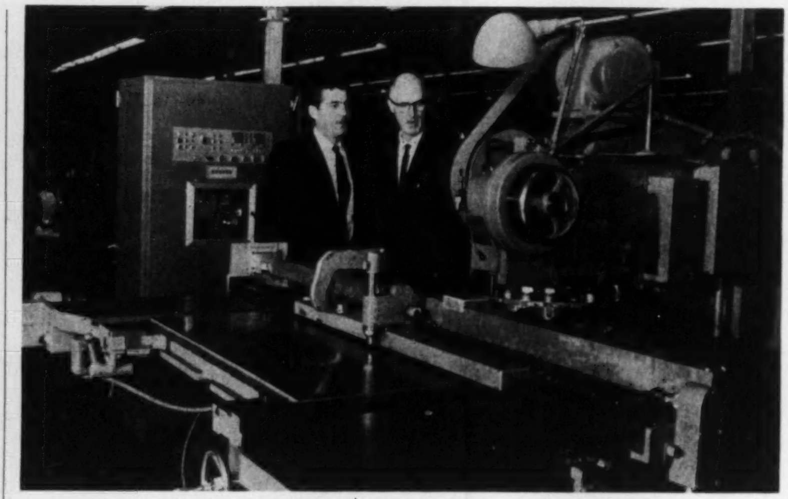
Circle 667 on Page 35



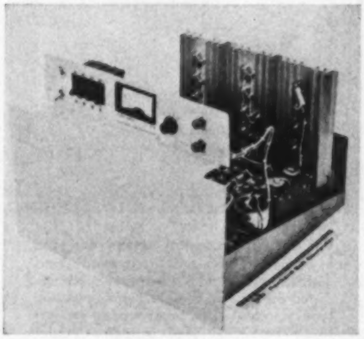
RETROFIT INSTALLATION of a standard numerical control unit to a turret punch press has been successfully completed. A two-axis control unit made by Hughes Aircraft Co. was used on this RA41P Wiedemann press. Special adaptation required for this application was the addition of electrically driven lead-screws to the table, and binary cams on the turret stations for turret position control. With this system, operating costs are reduced to one half that of manual punch press methods. All machine instructions are punched into tape by the shop's planning department. The transistorized control unit reads the tape data, positions the work and turret, and actuates the punch. Templates are no longer necessary, and accuracy is boosted from ±0.010 to ±0.004 linear tolerance.

---

ing and assistant general manager of Weston Instruments Div., Daystrom Inc. . . . **Lyman L. Campbell** elected vice president in charge of engineering for Package Machinery Co. . . . **Walter M. Gates** appointed manager of the St. Johnsbury, Vt. works of Fairbanks, Morse & Co. . . . **Dr. Harwood G. Kolsky** named manager of the systems science program at the San Jose Research Laboratory of International Business Machines Corp. . . . **E. M. Proctor** named vice president and director of production of the Bemis Bro. Bag Co. . . . **Eric H. Rask** appointed manager of product engineering for Veeder-Root Inc. . . . **Gilbert B. Richards Jr.** named president of OPW-Jordan Div., Dover Corp. . . . **Harris Shapiro** appointed vice president-engineering of Electro Dynamic Div., General Dynamics Corp. . . . **Edward Kibbitt** named supervisor of subsidiary operations of the Cutting Tool Div., Brown & Sharpe Mfg. Co. . . . **Karl Brandenberg** appointed chief engineer of Modernair Corp. . . . **W. F. Girouard** named director of industrial engineering at Librascope Div., General Precision Inc. . . . **Harold W. Buus** appointed general manager and **William G. Luedtke** named director of engineering, both at Stearns Magnetic Products Div., Indiana General Corp. . . . **Wilson R. Smith** appointed plant manager, semiconductors for CBS Electronics, manufacturing division of the Columbia Broadcasting System Inc. . . . **Robert McGaughey** named manager of Systems Engineering Department of Computer Measurements Co. . . . **Lewis M. Duckor** appointed chief engineer for Norwood transducers at the American-Standard Controls Div. . . . **G. A. May** named executive vice president and general manager of the Allen Mfg. Co. . . . **William T. Brown** appointed vice president in charge of manufacturing at Philadelphia Gear Corp. . . . **Leon F. Edelson** named director of engineering at Ultrasonic Systems Inc. . . . **Robert Conner** appointed product manager, palletizers for the Industrial Machinery Div., Challenge-Cook Bros. Inc. . . . **Dr. John E. Niesse** named manager of the process development department of the Research and Development Div., Carborundum Co. . . . **William Peters** appointed division manager of the Air Conveying Div., Flo-Tronics Inc.

SPOTLIGHTING PLANTS

Avery Adhesive Products Inc. have formed a new division to be called Applicon Machines. The division will manufacture equipment such as pressure-sensitive label dispensers and pressure-sensitive label imprinters. . . . **Bemis Bro. Bag Co.** has announced plans to construct a 200,000 sq-ft plant at Houston, Tex. The plant will manufacture paper, textile, and open-mesh bags. . . . **Mite Corp.** is the name of a newly-formed corporation developed from the merger between Greist Mfg. Co. and Teleprinter Corp. Firm will produce miniaturized integrated telegraph equipment, subfractional horsepower motors and associated assemblies. . . . **Minneapolis-Honeywell Regulator Co.** has formed a separate computer department in its Special Systems Div. The new department will be responsible for engineering and marketing programs for integrated industrial process control systems incorporating the 290 digital computer. It will also co-ordinate activities with the company's Electronic Data Processing Div. . . . **Cast-Master,** a department of H-P-M Div., Koehring Co. will move its entire manufacturing and administrative operations to Mt. Gilead, Ohio. . . . **American Systems Inc.,** affiliate of Schlumberger Well Surveying Corp. has acquired the Instrument Div. of Micro-Path Inc. This includes all inventories, contracts, and patents, as well as development, manufacturing and marketing rights, pertaining to their line of electrochemical gas sensing devices. . . . **General Electric Co.** has started construction of a poly-



BATTERY OPERATED computer is manufactured by Packard Bell Computer, Div., Packard Bell Electronics. In normal operation, the computer is operated from battery which is continuously regenerated by trickle charging. If the 115 v input to the charger is interrupted, the computer can continue operation for more than one hour.

MARK ELECTRONIC COMPONENTS

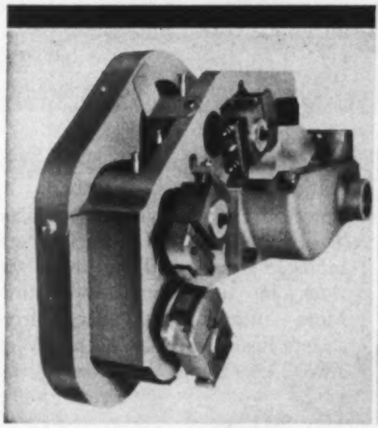
SYMBOLS, TRADEMARKS, LETTERING, NUMBERING—CONSTANT OR VARIABLE

CYF 10C
680 J

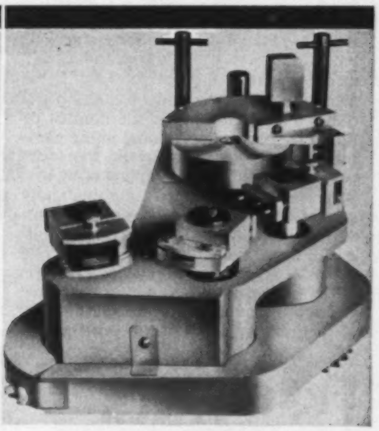
MATTHEWS *Offset* PRINTERS

WITH INTERCHANGEABLE STEEL TYPE presents a spectacular advancement in quality marking of delicate components requiring frequent changes in data, lettering or numbering. The combination of the offset printing principle plus the flexibility of a quick-change steel type holder results in the perfect marking of flat, contoured or cylindrical parts—whether constant or variable identification is required.

Matthews Offset Printers can easily be installed to fit in your present production line.



MODEL 6301 for over-the-line installation, provides identification on conveyor fed products of metal, glass, plastic and fibre.



MODEL 6302 designed as a side printer for installation adjacent to parts handling system to print parts as they pass the printer.

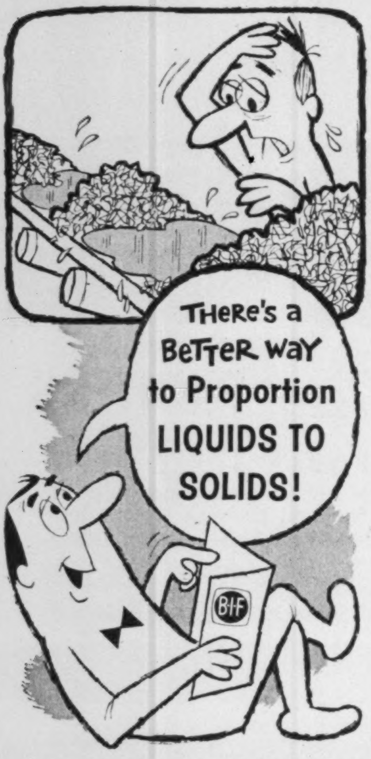
Write today for more information and if possible send a sample part for test marking.

MATTHEWS
MARKING
PRODUCTS

JAS. H. MATTHEWS & CO.
3945 FORBES AVENUE • PITTSBURGH 13, PENNA.

Circle 668 on Page 35

B-I-F POSITIVE CONTROL OF MATERIALS FLOW


THERE'S a BETTER WAY to Proportion LIQUIDS TO SOLIDS!
B-I-F

Does your present proportioning system suffer from short range limitations? Can one unit run empty and waste ingredients . . . spoil end product? B-I-F offers a new concept in the control of liquid to solid proportioning in the combination of its continuous dry materials weigher and its closed loop metering system. Fail-safe system — automatically stops when either unit is empty . . . prevents ingredient waste and product spoilage. Forced balance weighing principle provides wide range, greater accuracy. System governed by simple gravity flow . . . operates automatically, continuously . . . features explosion-proof construction!

Free Facts

B-I-F continuous liquids-to-solids proportioning system adapts to a wide range of applications. Spray nozzle easily applied on liquid unit. Request complete details . . . write for free facts today!

B-I-F Industries

BUILDERS-PROVIDENCE • PROPORTIONEERS • OMEGA
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Circle 669 on Page 35

carbonate product and process development laboratory in Mt. Vernon, Ind. The facilities will allow increased developmental effort on Lexan copolymers, elastomers, and films. . . . **Servo Corporation of America** has been granted a license to manufacture and market automatic servo plotters and phase and amplitude detectors developed by Republic Aviation Corp. . . . **Kearfott Div., General Precision Inc.** has opened a new plant in Los Angeles to consolidate engineering, production, sales, and administrative activities. . . . **New York Air Brake Co.** has acquired Feedback Controls Inc., manufacturers of servo components and systems, and electronic computational equipment. Plans are to operate Feedback Controls as a subsidiary of New York Air Brake.

MEETINGS AND EVENTS

May 7-10—

National Office Management Association. International conference and office equipment exposition will be held Sheraton-Jefferson Hotel, St. Louis. More information available from association headquarters, Willow Grove, Pa.

May 8-12—

Castings Congress & Exposition. National congress sponsored by American Foundrymen's Society. To be held in San Francisco; exhibits in Brooks Hall, technical sessions in the Civic Auditorium. More information available from society headquarters, Golf and Wolf Rds., Des Plaines, Ill.

May 9-11 —

Western Joint Computer Conference. Conference and exhibit sponsored by the National Joint Computer Committee formed by representatives of the IRE, AIEE, and ACM. To be held at the Ambassador Hotel, Los Angeles. Additional details from Dr. Walter F. Bauer, general chairman, Ramo-Wooldridge, Div., Thompson Ramo Wooldridge Inc., 8433 Fallbrook Ave., Canoga Park, Calif.

May 9-11—

Material Handling Institute Inc. Cosponsored by American Material Handling Society Inc. and Material Handling Equipment Distributors Association. Exhibits and conferences to be held at the Trade and Convention Center, Philadelphia. Details available from MHI headquarters, One Gateway Center, Pittsburgh 22, Pa.

May 10-12—

American Society of Mechanical Engineers. Production engineering conference to be held Royal York Hotel, Toronto, Ont., Canada. More information from society headquarters, 29 W. 39th St., New York 18, N. Y.

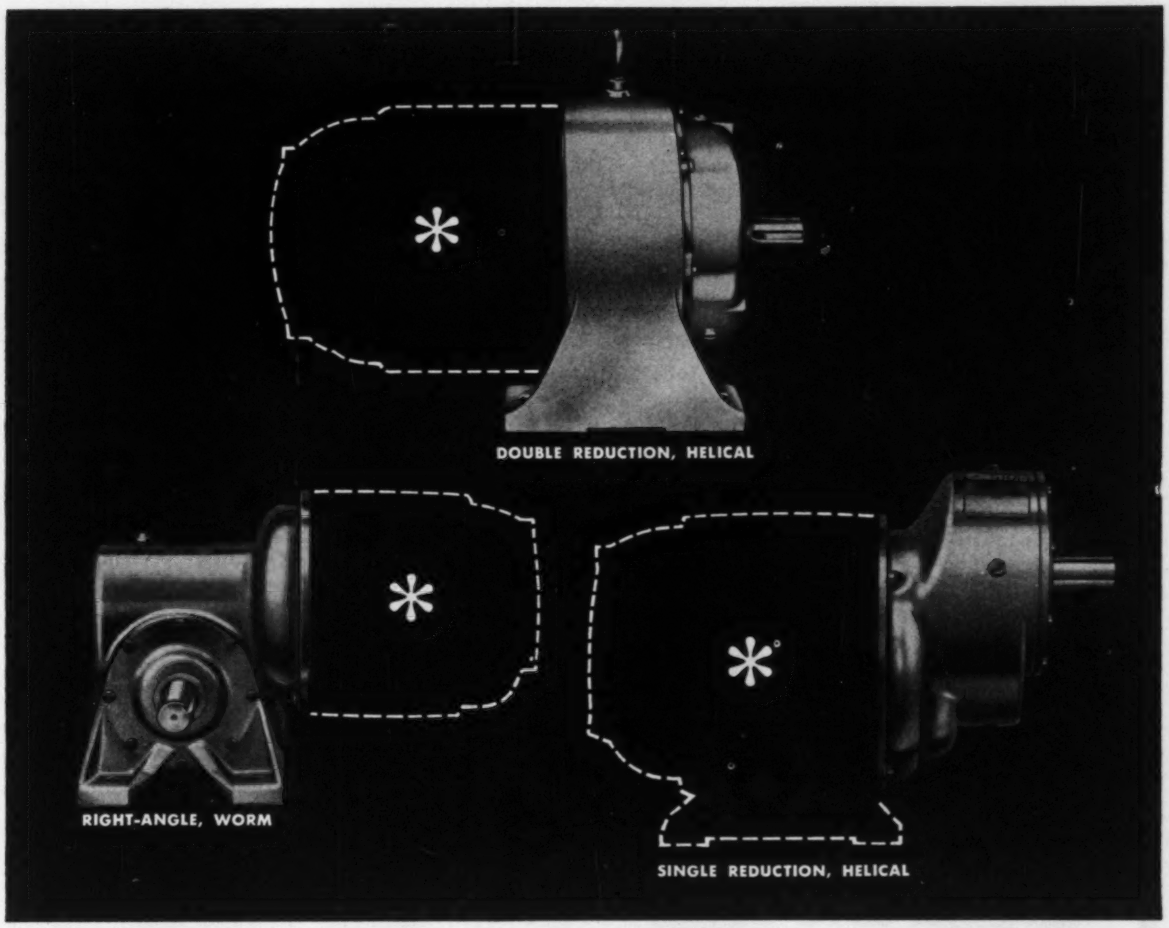
May 10-12—

Pulp and Paper Instrumentation Symposium. Cosponsored by the Instrument Society of America and the Technical Association of the Pulp and Paper Industry. To be held at Northland Hotel, Green Bay, Wis. Details available from ISA headquarters, 313 Sixth Ave., Pittsburgh 22, Pa.

May 11-13—

American Institute of Industrial Engineers Inc. National conference and convention to be held at the Sheraton Cadillac Hotel, Detroit. Details available from James E.

CONTOURING control system designed by Bendix Corp. and designated Dyna Path-20 Series can use either binary-coded-decimal or straight binary punched tape formats. The binary-coded-decimal (BCD) format is used in point-to-point control systems, while the straight binary punched tape format permits compatible programming with previous Bendix systems. With the BCD format, it is possible to make, modify, reproduce, and verify tapes on a tape punching typewriter, thus preparing control tapes without the use of a computer.



Need a Motoreducer with an unusual drive motor?

LET REULAND TAILOR A MOTOREDUCER PACKAGE TO YOUR EXACT NEEDS . . .

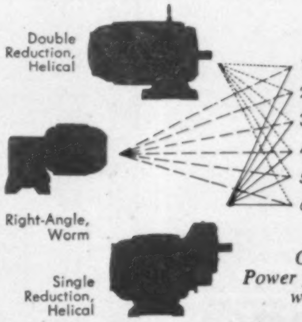
No longer must you "make something do" . . . no longer must you modify *your* machine to fit the *drive!* Hundreds of different speed and power variations can be developed from the three basic Reuland gear reduction units shown above.

This is made possible through the use of Reuland's famous "Xpandable-Design" idea.

Whether you need a simple motor-and-reducer — or an amazing, automatic combination with a special motor, gear reducer, magnetic brake and fluid coupling — Reuland engineers can quickly solve your drive problem.

Costs are lowered. Development time is saved. Your drive is *right*. Why not see first-hand what a Reuland Motoreducer can do for you. Refer to Sweet's 1961 Product Design File 7a/RE

*** ADD ANY ONE OF THESE 6 DRIVE MOTORS TO ANY OF THE 3 GEAR REDUCTION UNITS SHOWN ABOVE . . .**



1. Fluid-Shaft
2. Standard Squirrel Cage
3. Multi-Speed
4. Wound Rotor
5. Crane — Hoist duty motors
6. Torque motors

Our new brochure "Modern Power for Modern-Day Products" will be helpful in your work. Sent free on request.

A DEMONSTRATION UNIT FOR YOUR EQUIPMENT?

So sure are we you'll like what you see, we're offering to engineer a demonstration unit for your equipment without the slightest obligation. Just write us.

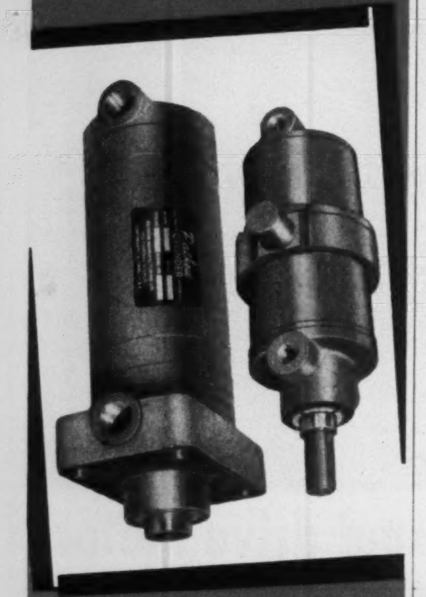
MODERN POWER FOR MODERN-DAY PRODUCTS
. . . ALL IN LIGHTWEIGHT ALUMINUM FRAMES!

REULAND MOTORS

Reuland Electric Company — Distributors in all principal cities
Western Division: Alhambra, California • **Eastern Division:** Howell, Michigan

Circle 670 on Page 35

Pathon
Cylinders
are
most ✓
DEPENDABLE
because



1. Screw thread heads to barrel attaching method gives maximum strength and requires minimum mounting area.
2. All mounting pads are integrally cast, and precision machined to assure greatest rigidity and perfect alignment.
3. Rod bearings, which are inboard of packing and pressure lubricated, provide longest possible service life.
4. Any wearing part can be replaced quickly, without complete disassembly.

Learn how dependable cylinders can be. Specify Pathon. A complete line of cylinder from 200 to 3000 P.S.I. Write for Catalog.

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MANUFACTURING COMPANY
3823 Pacific Avenue Cincinnati 12, Ohio

Circle 671 on Page 35

McCartney, AIIE Conference, Room 29, 4181 Oakman Blvd., Detroit 4, Mich.

May 15-16—
Packaging Industry Technical Conference. Sponsored by American Institute of Electrical Engineers, first annual conference to be held at New Ocean House, Swampscott, Mass. Additional information available from institute headquarters, 33 W. 39th St., New York 18, N. Y.

May 21-23—
Fluid Controls Institute Inc. Annual meeting to be held at the Cloister, Sea Island, Ga. Further information available from institute headquarters, P. O. Box 667, Pompano Beach, Fla.

May 22-24—
American Society for Quality Control. Annual convention and exhibition to be held at the Sheraton Hotel, Philadelphia. More information available from society headquarters, 161 W. Wisconsin Ave., Milwaukee 3, Wis.

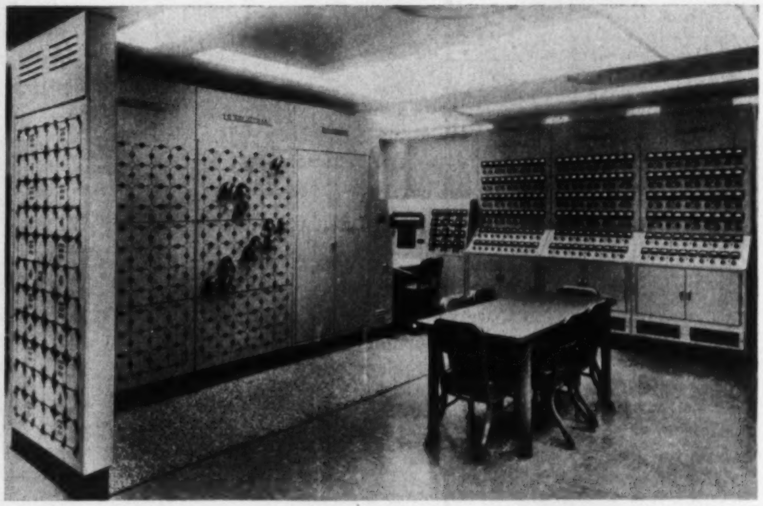
May 22-24—
National Telemetering Conference. Cosponsored by AIEE, ARS, IAS, IRE, and ISA. To be held at Sheraton-Towers Hotel, Chicago. Details may be obtained from ISA headquarters, 313 Sixth Ave., Pittsburgh 22, Pa.

May 22-25—
Design Engineering Show. Exposition with conference sponsored by the Machine Design Division of the American Society of Mechanical Engineers. To be held at Cobo Hall, Detroit. More details from Clapp & Poliak Inc., 341 Madison Ave., New York 17, N. Y.

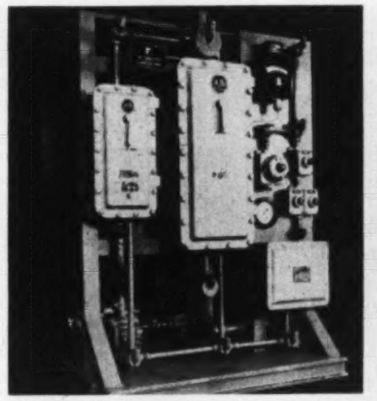
May 22-26—
American Society of Tool and Manufacturing Engineers. Technical conference and exhibit to be held at the New York Coliseum, New York. Complete information may be obtained from society headquarters, 10700 Puritan, Detroit 38, Mich.

May 24-26—
Electronics Industries Association. Annual convention to be held Pick-Congress Hotel, Chicago. More information available from association headquarters, 1721 DeSales St. N.W., Washington 6, D. C.

June 5-8—
Eastern Seaboard Apprenticeship Conference. Cosponsored by Bureau of Apprenticeship and Train-



FLUID NETWORK analyzer, used to simulate steady state conditions in a pipeline network, has been constructed and installed by Standard Electric Time Co. at Western New England College. Electrical analyzers such as these are used by water and gas utilities as an integral part of their planning and engineering programs to determine, in advance, the system performance under projected conditions of use. The analyzer is used jointly by the college and Standard to train students in the theory and operation of analog computers and for demonstrations to prospective customers.



ELECTRIC, explosion-resistant fluid heat transfer unit is adaptable to processes needing constant heat—jacketed kettles and pipelines, heated molds, and heated rolls. After the unit is hooked up to a process, it will provide constant temperature automatically, at any temperature selected up to 600 F. Explosion-resistant construction eliminates the danger of fire or explosion. Radcor Inc. designed the unit.

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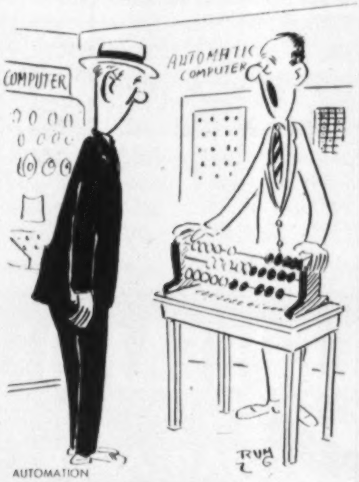
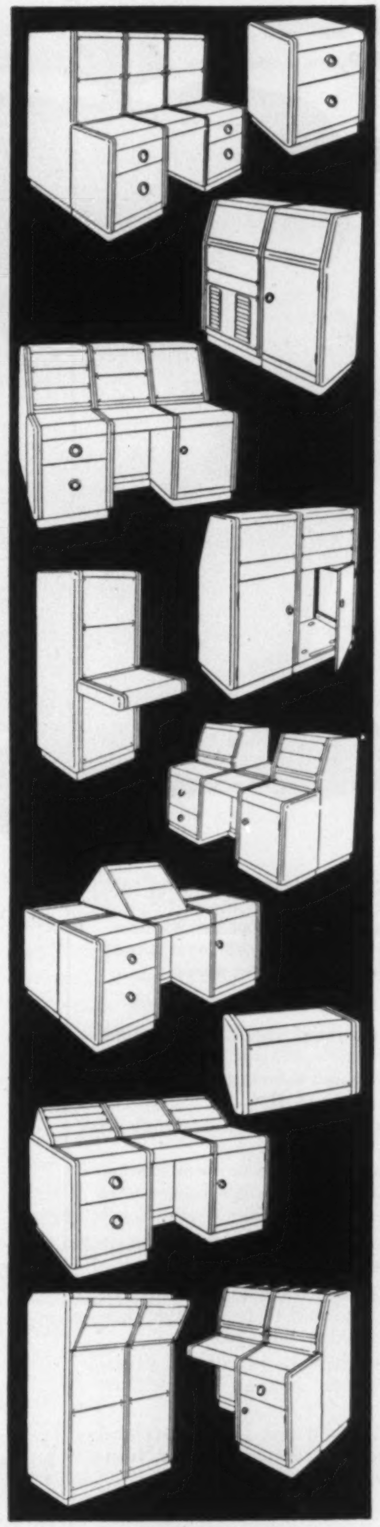
ing of U. S. Dept. of Labor with other groups. To be held Equinox House, Manchester, Vt. More information available from Bureau of Apprenticeship and Training, U. S. Dept. of Labor, Washington 25, D. C.

June 5-9—
Society of the Plastics Industry. National plastics exposition and conference to be held the New York Coliseum and Commodore Hotel, New York City. More information from society headquarters, 250 Park Ave., New York 17, N. Y.



AUTOMATION

"Now if you're looking for something more economical . . ."



HUNDREDS OF Widths, Depths & Heights TO MEET YOUR ENCLOSURE REQUIREMENTS WITH EMCOR STANDARD CABINETS

- Cut costly enclosure design time. Select your packaging needs from a complete line of standard and heavy duty EMCOR Cabinets.
- EMCOR MODULAR ENCLOSURE SYSTEM Cabinetry provides for thousands of control center combinations.
- Engineered simplicity of basic frames and components affords quickest and easiest erection of control center assembly.
- EMCOR Cabinetry Engineers backed by the research and development "know-how" of the Roy C. Ingersoll Research Center set the pace for the packaging needs of electronics, instrumentation and electro-mechanical engineers from coast to coast.
- Rugged frame construction surpasses all standard requirements for increased load carrying capacities.
- Compatible cabinet design assures simplified and economical expansion at any time.
- EMCOR Cabinet manufacturing meets rigid quality-controlled craftsmanship standards.
- Nationwide organization of EMCOR Sales-Engineering Representatives assist in planning stages and assure customer satisfaction beyond the sale.

Condensed Version of Catalog 106 Available Upon Request.

Originators of the Modular Enclosure System

QUALITY EMCOR PRODUCTS
INGERSOLL B-W PRODUCTS
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INGERSOLL PRODUCTS
Division of Borg-Warner Corporation
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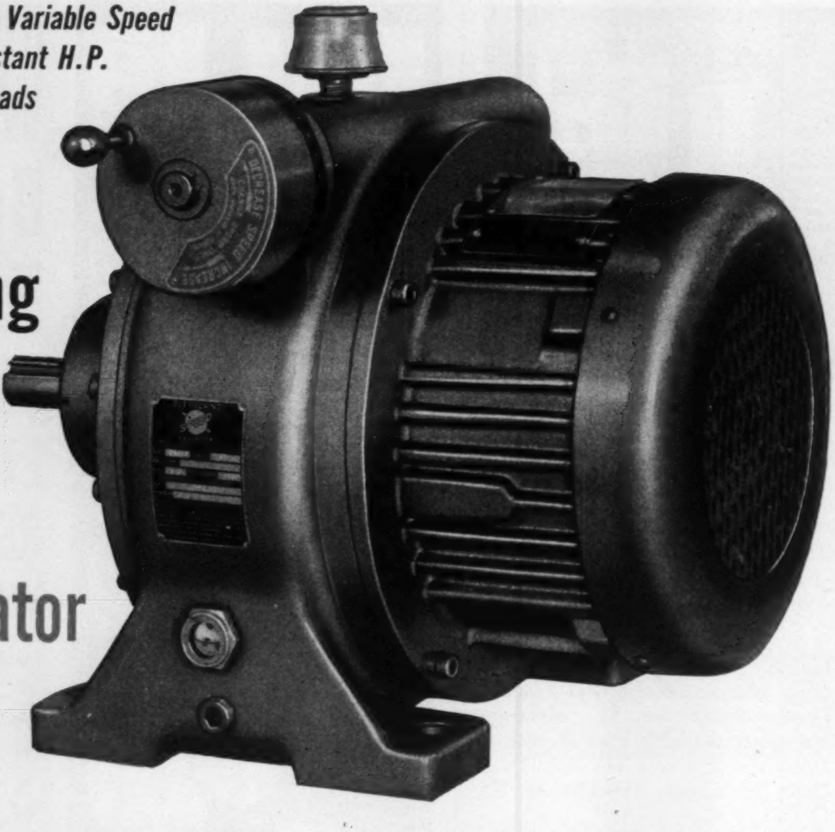

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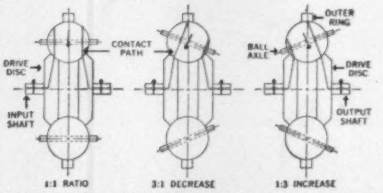
For complete engineering information on the New Cleveland Motorized Speed Variator, write for free, illustrated bulletin Number 275 or contact your Cleveland representative today.

How The Speed Variator Works

Power is transmitted through input shaft to a beveled drive disc in contact with axle-mounted alloy steel drive balls. Input shaft rotation causes balls to rotate about their axles. Power is then transmitted from all rotating balls to output shaft by similar ball-disc contact on the output side. Output speed is determined by relative lengths of contact paths on input and output sides of the balls. By tilting both axles and balls, relative lengths of the two contact paths are varied to give increasing or decreasing ratios as shown on sketches.



1:1 RATIO 3:1 DECREASE 1:3 INCREASE

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CLEVELAND
SPEED VARIATOR

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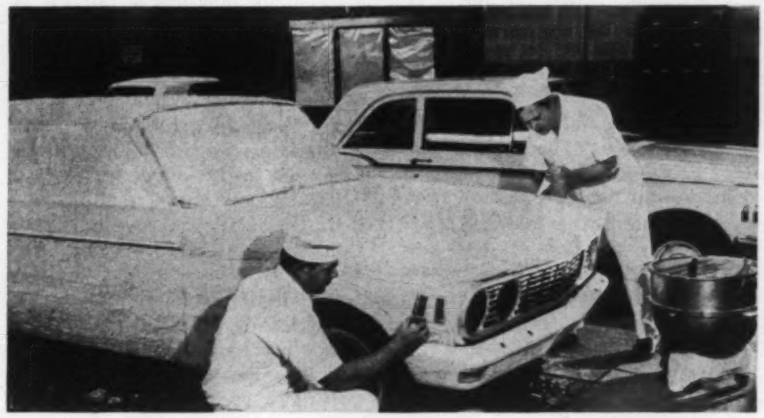
detroit dateline

By **LEE D. MILLER**, Associate Editor



Special manufacturing job shown above resulted in a birthday cake the size and shape of a Comet to celebrate that compact's first anniversary. The layers of cake—some 90 by one count—were built up on an actual chassis with scrap body stampings to form a base. The car-cake was finished in green frosting to tie in with St. Patrick's Day festivities on the day following the cake cutting. The top third of the entire car-cake was edible.

Baking Cakes

"IF I knew you were coming I'd have baked a cake . . ." so run the lyrics of a once-popular song. It would not have been appropriate music at a shindig staged recently by the Lincoln-Mercury Division at Ford's Lorain, Ohio, assembly plant. They knew some people were coming because they had invited them to celebrate the first birthday of the Comet.

The birthday party was complete with a cake which was a full-size replica of the year-old compact.

For an extra touch of the theatrical, the cake was moved down the final assembly line before it was cut. Leading and following it on the conveyor were regular units being assembled. As it moved along, the car-cake received finishing touches of frosting and a candle for a radio aerial in its "final assembly." Guests and employees assisted in the disassembly operation which followed the cake cutting ceremony. It was good cake too.

The manufacturing engineering talent on most automotive teams is not called on to bake edible car-sized cakes. But they are asked full time to whip up recipes to accomplish stated production goals, and to bake up batches of facilities to do the job. As some slightly singed participants in such activity might hasten to point out, the thoroughly baked developments will probably come out of the oven in good shape—but watch out for those half-baked ones.

More Front Burner Cooks

Though some of the political smoke screen of the last few months seemed to deny current use of such manufacturing "culinary arts," there have been several examples to indicate that some politicians have been short on information or guilty of oversights or misrepresentations.

Chevrolet and Fisher Body Divisions of General Motors have announced a new complex of automobile assembly plants to be put up in Fremont, California. The multibuilding installation will occupy a site of 300 acres and provide approximately 2 million square feet of space. The program has been scheduled for completion in time to assemble 1963 model automobiles. A $30 million cake such as that deserves some respect from sneezers no matter who they might be.

Meanwhile Back at the Ranch

Back in the Detroit area, new facilities are being cooked up too. A short while ago the first 50,000-pound coil of strip steel was put through a newly installed 4-stand tandem cold rolling mill at Ford's Rouge plant. The 60-inch mill is part of a $35 million program to improve the facilities of their Steel Division.

The recipe for handling in this installation is designed to maintain a smooth flow of coils to and from the high speed cold reduction process. Coil conveyors handle coils of strip to and from the new mill. The coils are moved under pushbutton control from the time they are placed on the entry conveyor by an overhead crane until they leave the mill area on a conveyor into an annealing bay. This handling system includes an upender which transfers the finished coils from the delivery conveyor to a storage conveyor.

An automatic gage control system measures and regulates the thickness of the strip moving through the mill. Coarse gage control is effected at the first stand, and finish gage measurement and regulation are performed at the fourth stand. Force gage instruments are included in all stands to indicate the force being applied to the strip as it passes through the work rolls of each stand. A tensiometer is located between each pair of stands in the mill to indicate the amount of tension on the steel strip.

Cooking with Gas

In its Marion Forge Division plant at Marion, Ohio, Eaton Mfg. Co. has just shown part of the recipe it expects to use for expansion of its forging business. Occupying a new addition to their forge shop is an automated forging line that includes a mammoth 6000-ton mechanical forging press built by Ajax Mfg. Co. As presently set up, this big press can produce ring gear forgings from hot billets with three squeezes, one in each of three die stations. Previous production method for such forgings was to beat them out by drop forging on board hammers.

Three hits in the big press accomplish a job for which ten to twenty times that number of blows are required by hammers in the plant. Paul Olson, general manager of the division, reports that the new equipment also produces better quality forgings with fewer surface defects due to hammered-in scale inclusions.

In addition, the system operates with less scrap per piece since the press can make a given forging from a smaller billet than is required in hammer production. As much as a third of the billet weight becomes scrap in the hammer operations. Die cost per forging produced is reduced too.

Workpiece size billets are heated for the press forging operation by a gas-fired rotary hearth furnace built by Selas Corp. of America. Billets of the proper size are fed to the operation on a conveyor. A two-armed handling device also designed by Selas puts the cold billets into the furnace one at a time and simultaneously removes individual heated billets. Billets are placed in the furnace in two rows forming two concentric circles on top of the hearth.

Loading and unloading of the furnace are automatically controlled on a time cycle. The loading carriage is reciprocated by a hydraulic cylinder, and the manipulator arms are advanced an extra increment by auxiliary cylinders on alternate cycles to accommodate the two-row billet arrangement in the furnace.

Put and Take Automatically

After a heated billet is taken from the furnace it rolls down a gravity conveyor to the forging press. Since the billets shouldn't be held in the furnace longer than the prescribed time, the unloader continues to take them from the furnace even if the press should stop operating. Excess billets in such a situation are diverted from the conveyor to a handling container.

For ring gear forging, the press has been set up for a three-die operation—buster, blocker, and finish. A side loader takes the hot billet from the roller conveyor and puts it on the lower half of the buster. The press cycles, then a manipulator mounted at the rear of the press moves in, takes the workpiece to the other side of the press bed and puts it on the lower half of the blocker. Again the press cycles and the manipulator comes in and moves the work to the finish die in the center of the bed. After the press cycles a third time the manipulator takes the forging from the press and puts it on the discharge conveyor.

Side loader and manipulator for the press were cooked up by the Eaton Technical Center. They are hydraulically actuated and sequentially cycled by a static control system. This control system for the side loader and manipulator was tied into the control system furnished on the press. Repetitive cycling of the press and its handling devices can therefore be completely automatic.

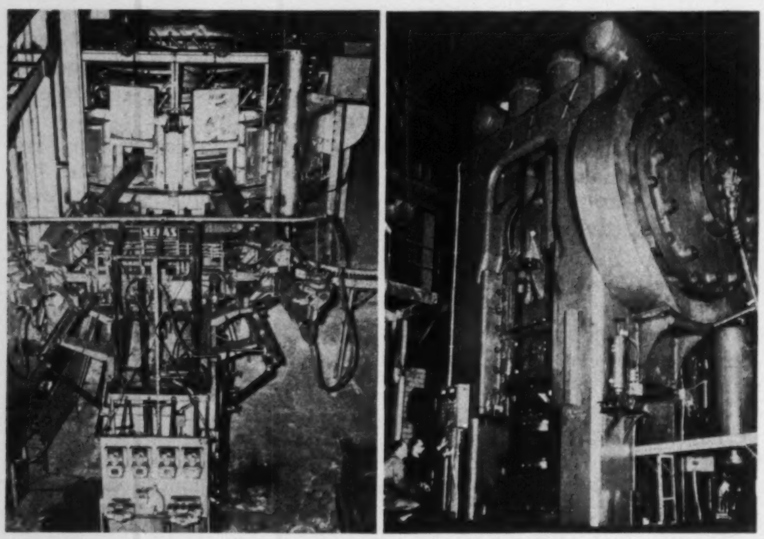
One of the guiding policies adopted in laying out this automated press installation was to avoid clutter around the press. Hydraulic power pack for the side loader and manpulator is located below floor level with removable floor plates for access. The static control system and other electrical controls are placed on a mezzanine along the adjacent wall of the building.

Change in Recipe

Installation of this big mechanical forging press is part of a general plan to shift the type of forging capability available at Eaton. They decided some time ago to phase out their board hammer facilities in a shift to presses. Besides the other reasons mentioned earlier for using presses, they feel the use of presses will make their shop a better place to work because slam of the board hammers will be replaced by the quieter press operations.

The more than $1 million invested in this new manufacturing recipe at Eaton is a pretty good drop in anyone's bucket.

And to the eye of this observer it appears that autodom's automaters are still hard at work baking bigger and better cakes.



Rotary hearth furnace at left automatically heats and delivers billets to the 6000-ton mechanical forging press shown at right. Billets for forgings weighing up to 130 pounds are automatically loaded on the hearth of the furnace, indexed through three controlled heat zones and heated to about 2200F. Hot billets, automatically unloaded from the furnace, are loaded into the press by a side loader whose operating position is at lower right. The loader was not yet installed when this photograph was taken. Workpieces are indexed between die stations and unloaded through rear of press by an automatic manipulator which is cycled by a static control system.

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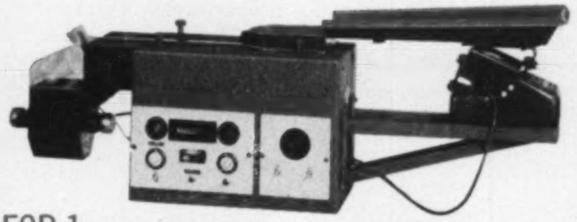
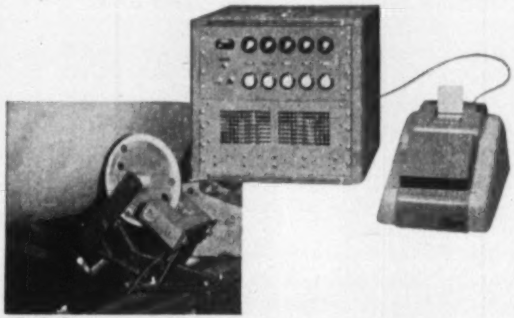


FCB-1 High speed, automatic, small parts counter-batcher. Portable —Feeds, counts and batches small parts, tablets, hardware, etc.

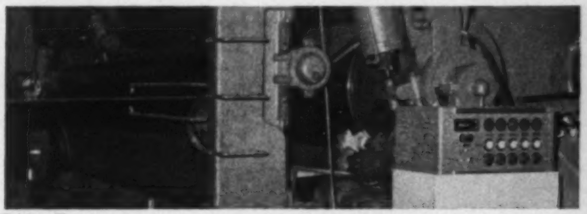


LF-1A Lineal footage measurement, electronically . . . Capable of length measuring continuous production items, i.e., paper, wire, rope, ribbon, etc.

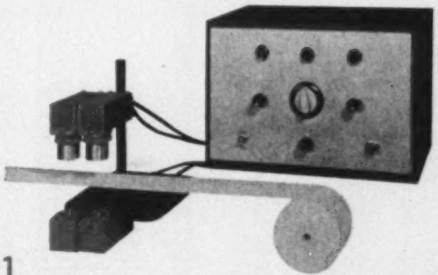
Features visual and printed readout.

P2-RM A preset type counter capable of counting batches in any desired quantity 1-100 (inclusive) with a built-in, 2 scale, rate meter calibrated in "thousands per hour".

PDC The Post "difference" counter . . . capable of maintaining counts of two (or more) variables and acting to control exact difference, i.e., shafts running at different RPM where it's important to maintain "difference" ratio. Many other applications. Adds, subtracts and visually indicates condition.



PW-5 Shown in paper making application. The counter is connected to a lineal footage measuring unit which accurately records paper production. Also provided is a "paper break detector" which will instantly shut off the machine should a web break occur.



ER-1 Edge register detector. Designed to control materials manufactured or processed in a web form. Detects web edge position with extreme accuracy. Inward or outward displacement of web actuates photoelectric control relays for correction.

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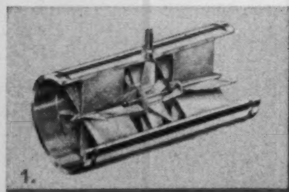
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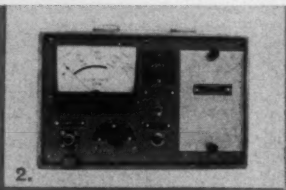
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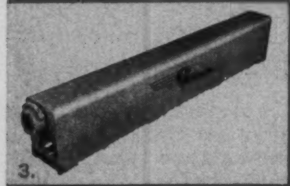
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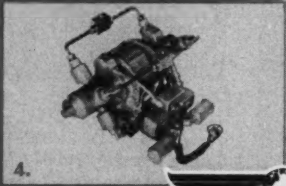
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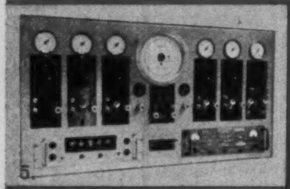
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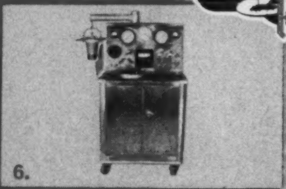
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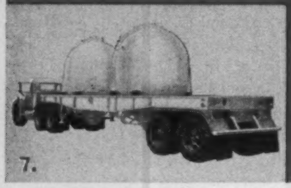
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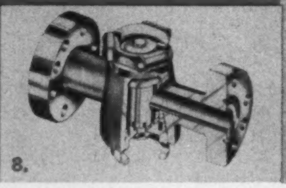
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Circle 675 on Page 35

around the triangle

SYNCHROS AND RESOLVERS ARE SOLID NOW

A Hall-effect resolver has been developed by Kearfott Co. Inc. to simulate the performance of a wound resolver, operate over a wide range of frequencies, and exhibit outstanding functional accuracy without quadrature components. The development resulted from work to build an automatic resolver tester for Frankford Arsenal to perform quadrature voltage and functional accuracy tests to 0.005 per cent at both 60 and 400 cps.

TOMATO SORTING AUTOMATED

Color sensitive machine that sorts tomatoes according to ripeness has been developed by Electric Sorting Machine Co., Div., Mandrel Industries Inc. Each tomato passes through a photoelectric color sensing device. An optical system scans the tomatoes and passes reflected light over a striped mirror that divides it between two phototubes—one for red, one for green. The proportion of red to green determines into which of five possible categories the tomato should be put. Machine can sort 450 tomatoes per minute.

STANDARDS BOARD FOR PACKAGING AND HANDLING

Standards board has been organized by American Standards Association, to supervise the rapidly growing standards program in the packaging and materials handling field. Function of the group, to be known as the Packaging and Handling Standards Board, will be to act on matters affecting scopes, sponsors, and standards in such fields as pallets, metal drums and pails, motor oil cans, freight containers, shipping cases for petroleum, and loading platforms at freight terminals and warehouses. The board will also be concerned with related projects now under way in the International Organization for Standardization.

CIGARETTE PACKAGE COMPUTER

Microminiature computer unit which is about the size of a package of cigarettes, is designed to show feasibility of thermionic integrated micro module (TIMM) concept developed by General Electric Co. The computer used for demonstrations is a three-bit parallel adder containing 16 NOR modules. Each of the modules contains a triode, five diodes, and two resistors. Input information consists of positive signals from a 15,000 ohm source fed to the proper terminal for a zero or a one. Output is in binary form, the ones are 4 v, the zeros are 0 v. TIMM circuits are radiation tolerant, require very little power, and operate at 580 C making use of heat that would normally cause malfunction in transistorized computers.

CONVERTING BETWEEN ULTRASONIC AND ELECTRICAL ENERGY

Transducer for converting electrical energy into ultrasonic energy and vice versa at microwave frequencies has been developed by Bell Telephone Laboratories. The transducer consists of a plate of piezoelectric semiconductor on which a thin metal film is deposited. The film constitutes a nonohmic rectifying contact which causes a depletion layer to form. Thickness of the depletion layer can be controlled with a negative bias voltage across the interface. When an ac voltage is applied, most of the voltage drop occurs across the layer, and the layer behaves in a manner similar to a very thin piezoelectric crystal which is bonded to a solid. Since the layer is thin, the electric field is very large and considerable piezoelectric stress can be produced in the layer.

AUTOMATION

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CARD INVALID WITHOUT COMPANY NAME—TYPE OR PRINT

NAME ____________

TITLE ____________

COMPANY ____________

PRODUCT MANUFACTURED ____________

ADDRESS ____________

CITY ____________ ZONE ______

STATE ____________

This card good until July 15, 1961

AUTOMATION MAY 1961

401	431	461	491	521	551	581	611	641	671	701	731	761	791	821	851
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430	460	490	520	550	580	610	640	670	700	730	760	790	820	850	880

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FIRST CLASS
Permit No. 36
CLEVELAND, OHIO

BUSINESS REPLY MAIL
No Postage Stamp Necessary if Mailed in the United States
—POSTAGE WILL BE PAID BY—

AUTOMATION
Penton Building
Cleveland 13, Ohio

Reader's Service Dept.

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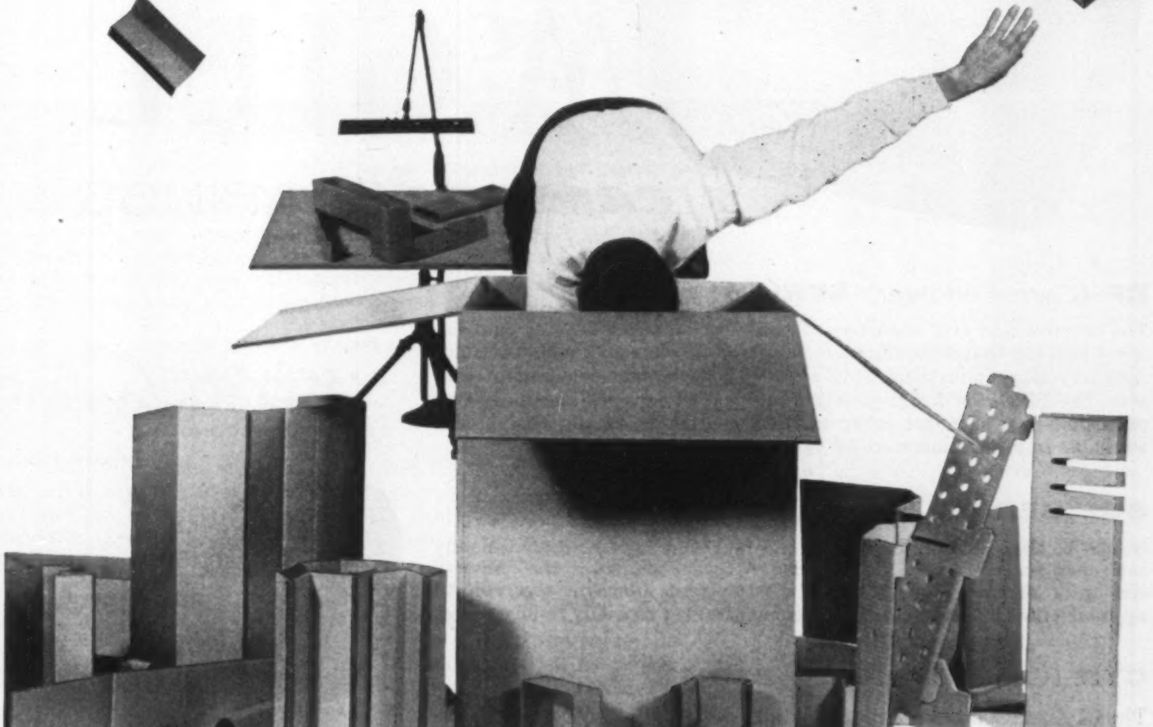
GAYLORD

designs out the extras

Last year, a certain manufacturer used a shipping container with 21 interior pieces. Although it was effective, assembly costs were high, so the container was presented to Gaylord designers for revision.

Result: a container with only 9 interior pieces, that has less tare weight, makes assembly easier, and reduces packaging costs 33⅓%.

Simplify *your* packaging problems. Let Gaylord design the extra pieces, weight, trouble and cost *out* of your corrugated containers. Call your nearby Gaylord Man today.



CROWN ZELLERBACH CORPORATION
GAYLORD CONTAINER DIVISION

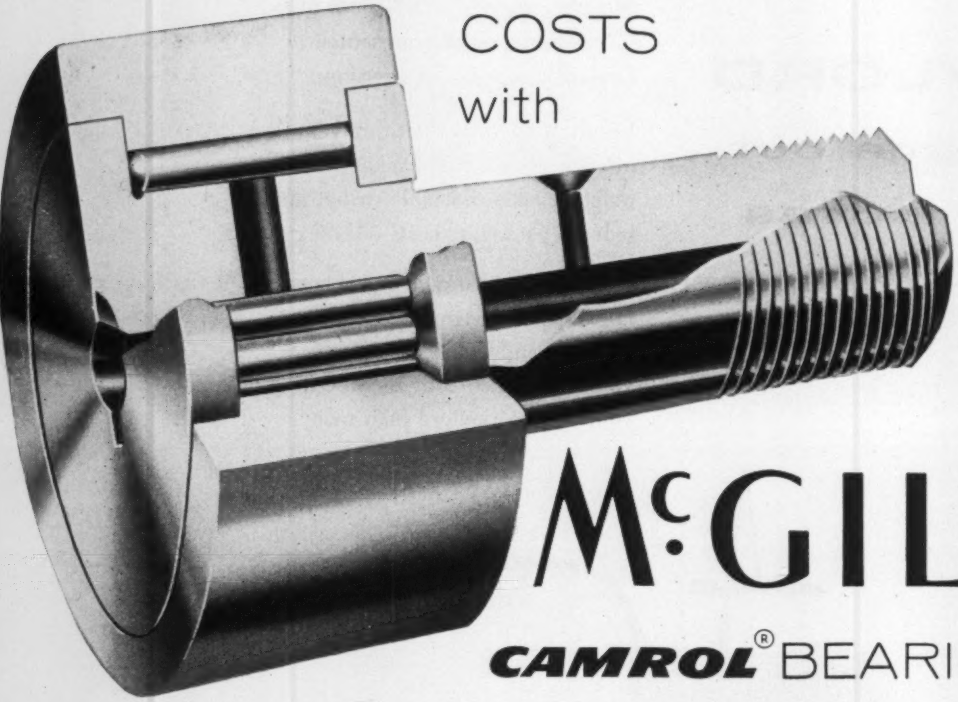
Gaylord Boxes

IN CANADA · CROWN ZELLERBACH CANADA, LTD. VANCOUVER, B. C.

HEADQUARTERS, ST. LOUIS
PLANTS COAST TO COAST

Circle 676 on Page 35

ELIMINATE UNNECESSARY ASSEMBLY COSTS with



Replace improvised units with readily available precision cam followers.

McGILL®

CAMROL® BEARINGS

CF (Cam Follower) SERIES

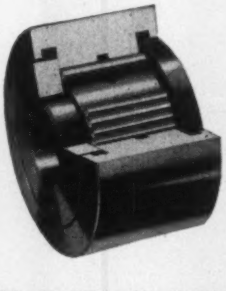
The original and still unsurpassed anti-friction roller bearing cam-follower bearing that adds efficiency at less cost to cam actuated, track and support roller applications. Built with full roller complement and integral stud, the CF series design provides high radial capacity and shock load protection in a compact roller with its own shaft. Easily applied and available in roller diameters of ½″ to 4″.

for the ultimate in:

- RADIAL CAPACITY
- SHOCK RESISTANCE
- SPACE ECONOMY

SCF SERIES.

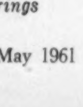
Sealed to keep contamination out and lubricant in. It is dimensionally interchangeable with the CF bearings. A turned groove in the center of the outer raceway bore provides a permanent lubricant reservoir to approach life-time lubrication requirements. Can be easily re-lubricated.



SCYR SERIES
(sealed)

CYR (Cam Yoke Roller) SERIES

The CYR series increases the adaptability of the CF bearing to all types of automatic machinery involving cam action or controlled-motion machine parts that require guide or support rollers. An inner ring replaces the stud for cam yoke roller mountings.



Write for Catalog No. 52-A for full information on McGill's needle roller bearings, and cam followers. Ask about recommendations for high precision special ball and roller bearings.

SCYR SERIES

This series provides a fully sealed Cam Yoke Roller type bearing. It is dimensionally interchangeable with the CYR bearings.

engineered electrical products

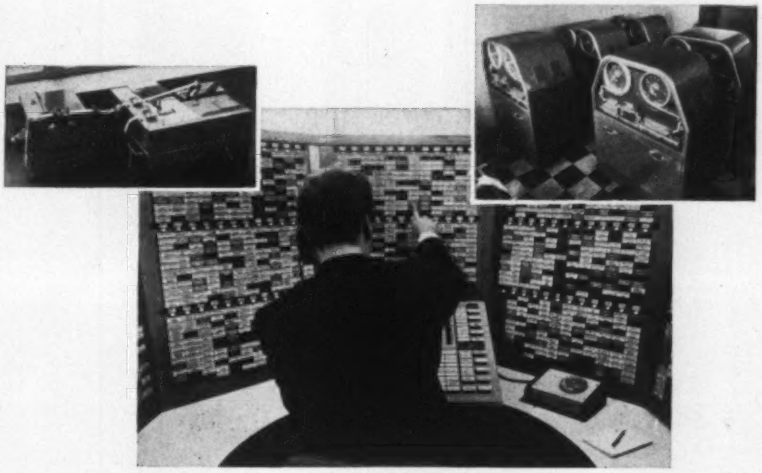
McGILL®

precision needle roller bearings

McGILL MANUFACTURING CO., INC., Bearing Division
401 N. Lafayette Street, Valparaiso, Indiana

Circle 677 on Page 35

international scene



Major components of order recording and invoicing system include panels with pushbuttons containing names of up to 3000 customers arranged alphabetically, tape punch (left inset) on which order information is recorded, and paper tape storage units (right inset) which contain full information about each customer and product ordered. Other equipment in system includes teleprinters that automatically prepare invoice and delivery forms and a summarizer that tallies daily product issues and values.

Project DORIS

UNDERGOING test and evaluation in England is a new, automatic approach to recording orders and preparing invoices for businesses handling a variety of products. The system—called DORIS for Direct Order Recording and Invoicing System—was developed by Creed & Co. Div., International Telephone & Telegraph Co. It is composed primarily of standard machines and components.

The system is in operation at a distribution depot outside of London and is being tested for Shell-Mex and British Petroleum Ltd. The depot, which handles more than 6 million gallons of assorted petroleum products per month, receives approximately 85 per cent of its orders by telephone. This volume is handled by a single clerk stationed at the system's control console.

When he receives a call, the operator first presses a button bearing the customer's name. Up to 3000 names can be accommodated on a series of panels at the console. The operator then presses buttons on a smaller panel to enter details of the order such as: Product type, quantity, delivery date, method of packing, and means of transportation. If special instructions are necessary, the operator presses a button which calls for the printing of an asterisk on the delivery ticket. Simultaneously, he notes the instructions on a pad.

When a complete order has been taken, the operator presses a *Transaction* or *End of Order* button. If he has neglected to include some essential information, a panel light informs him where the oversight occurred. Once this is corrected no further manual operations are necessary to produce a sales ticket or invoice.

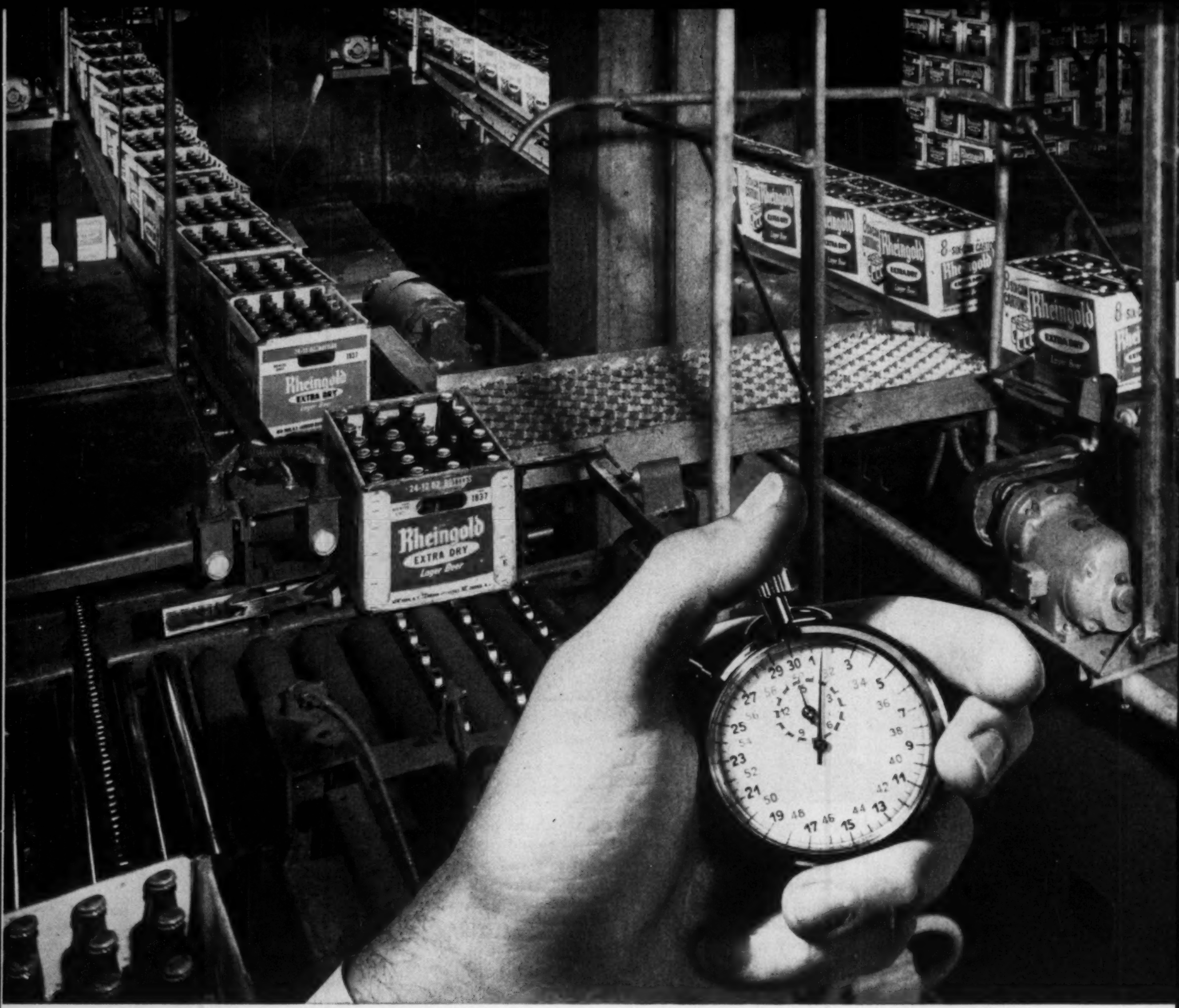
Four seconds later, all of the information entered by the clerk is transferred to punched paper tape. This tape is read, and from stored paper tape files complete customer and product information is obtained automatically. A customer file provides the full address of the customer and terms of trade; a product file contains descriptions and prices of the materials ordered.

A series of Creed teleprinters then combines these details to print out an invoice for the customer and a sales ticket. The sales ticket is passed to a routing clerk for briefing a delivery man.

While the sales ticket is being produced, the information needed for summarizing the day's transactions at the depot is punched on perforated tape. The tape is then held until delivery is completed, when it is fed into a summarizer that tallies the daily issues for each product type and sorts the sales ticket information into punched card sequence. The resulting detail and summary tapes, together with the printed daily summary of issues and values, are sent to the company's divisional office. There, they are run through a tape-to-card converter that furnishes at the central location all of the accounting and statistical information the company requires.

Ontario, Canada

Three new products for the evaluation, inspection, and sorting of paper have been reported by Electronic Associates Ltd. An Inspectaform system measures and records paper web formation for qualitative evaluation. The system indicates on a chart the general uniformity



MASTER GEARMOTORS AUTOMATE PALLET LOADING AT 1½ SECONDS PER CASE

This most practical application of Master Gearmotors results in fast, positive handling of beer cases to facilitate automatic pallet loading.

The trick is in the ability of these gearmotors to start and stop action up to 40 times per minute in order to corner and place cases into a pre-set palletizing pattern.

The pallet is loaded, 3 cases at a time, by a fast cycling operation. Magnetic brakes stop action instantly; motors quickly reverse and attain top operating speeds for 3 seconds, stop and reverse again.

The power system for the movement of cases is coordinated for fast delivery from bottling room to palletizing and thence to trucks. Right angle and parallel Master Gearmotors and brakemotors are used throughout . . . perform consistently where continuous duty cycle is a vital factor.

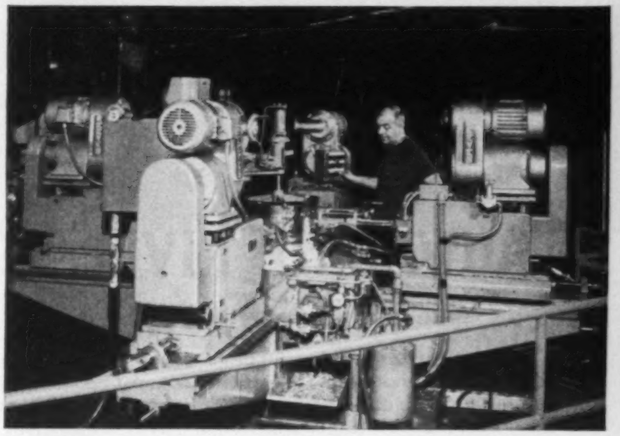
BUILDERS OF THE TOOLS OF AUTOMATION

A-1685

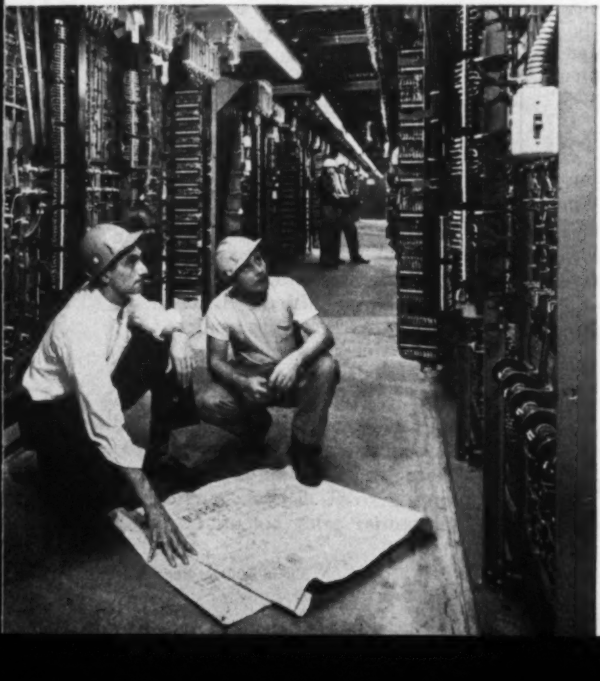
8 SIX-CAN CARTONS

ONE SELF-CONTAINED, COMPACT POWER PACKAGE. This MASTER GEARMOTOR has been operating outdoors for 5 years regardless of weather. It has no exposed high speed couplings, no V-belts, chains or sprockets. Engineering and assembly costs are reduced. You can simplify installations and save space with vertical, horizontal and flange mountings; output shaft over, under, left or right. Ratings 1/8 to 125 hp. in right angle, parallel or in combination. Right angle ratios are available up to 96:1; parallel 120:1. Bulletin E-2409.

CONTOUR EPOXY-COATED TO ELIMINATE ENCAPSULATION CRACKING. New RELIANCE ENCAPSULATED MOTOR . . . gives you positive protection from dust, dirt, acid and water. Unlike other heavy molded coatings, stator windings are vacuum-impregnated with epoxy resin at a uniform thickness, follow the contour of the windings. You get maximum flexibility, tensile and bond strength, plus quicker cooling . . . all vital to superior motor performance. Bulletin B-2108.



INFINITELY VARIABLE OUTPUT SPEEDS AT LOW COST. REEVES MOTODRIVES, shown here powering this 4-position drilling and boring machine, are used extensively for hundreds of production needs. Horsepower ratings from ¼ to 40, speeds from 1.71 to 4660 rpm. Speed variation ranges from 2:1 to 10:1. Available in hundreds of space-saving assemblies . . . with manual, remote or automatic process control (Airtrol). Bulletin M-592.



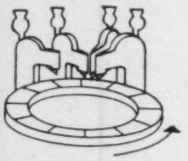
TOTAL SERVICE is an integral part of every Reliance product, from engineering and start-up assistance to maintenance and renewal parts. The photo shown here is typical of a Reliance Service Engineer's on-the-job availability—for maintenance and consultation on knotty problems. Every Reliance Sales Engineering Office and Distribution Center—nationwide—gives you the attention and experience necessary to assure the top performance you expect from the Reliance equipment you buy.

RELIANCE ELECTRIC AND ENGINEERING CO.

DEPT. 265A, CLEVELAND 17, OHIO • Canadian Division: Toronto, Ont.

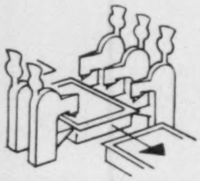
Circle 678 on Page 35

A FEW OF MANY POSSIBLE RIVETING HEAD POSITIONS THAT CAN BE USED

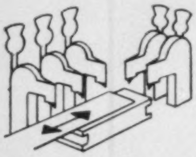


Rotating fixture showing suggested arrangement of riveting heads.

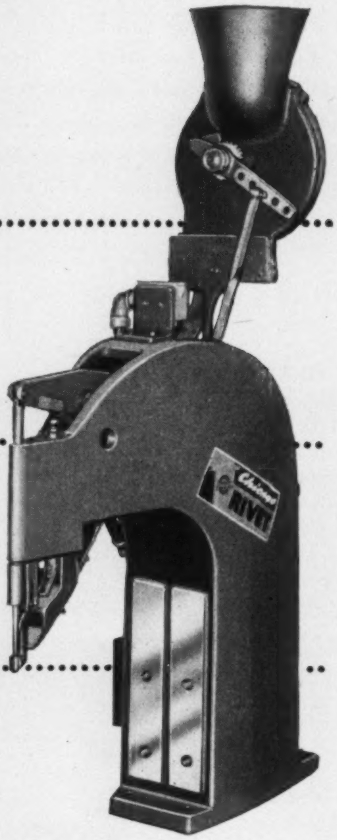
Riveting heads can be positioned for fastening on flat or curved assemblies.



Conveyor Belt permits multiple setting on both sides of an assembly.



Sliding fixture used for riveting 2 sides of an assembly.



AUTOMATE RIVET SETTING

for new low costs

For years assemblies made of metal and non-metal or a combination of both have been fastened most economically with semi-tubular rivets. And now even lower costs are possible with the thin-nose riveting heads designed by Chicago Rivet. These heads, pneumatically operated but electronically controlled, can be grouped in clusters on one or more planes and will set rivets as close as 13/16" apart. Automation, thru rotating sliding or continuous belt feeding and riveting stations, is possible. Riveting heads may be repositioned and used again on new assemblies.

CUSHIONED RIVETING REDUCES BREAKAGE

A pneumatic riveter upsets the rivet with a squeezing action which minimizes breakage and automatically compensates for slight variation in assembly thicknesses.

The suggestions of Chicago Rivet fastening specialists will prove most helpful. Call them—no obligation.

AIR-POWERED RIVETING CATALOG contains description and specifications of 8 single and multiple riveters—also rivet setters designed for automation.
RIVET CATALOG describes 1388 standard tubular and split rivets and 25 single and multiple motorized automatic rivet setters.

Chicago Rivet & MACHINE CO.
943 So. 25th Ave., Bellwood, Ill. (Chicago Suburb) • Branch Factory: Tyrone, Pa.

of a sheet, predominant floc size, and intensity of wire mark. The presence of streaks, felt marks, press marks, and other flaws can also be detected. Inspectalarm electronically detects, signals, and flags faults in high-speed running webs. A tape is made which records the positions of flaws. This tape can accompany reels made from the web material. Inspectasort scans the surface of a running web feeding into a sheet cutter and diverts imperfect sheets into a reject pile after they have passed through a cutter. Equipment is available in the U. S. from Kohler Coating Machinery Corp.

Tokyo, Japan—

Evidence of a growing market for electronic data processing equipment in Japan is seen in four transactions involving U. S. firms.

National Cash Register Co. has announced that an order for an NCR 304 electronic computer was placed by Fuji Iron & Steel Co. The order, totaling over $1 million, calls for a complete 304 EDP system and 23 associated accounting machines. The installation will provide centralized electronic accounting for 27,000 employees and four factories.

A Univac II electronic computer will be supplied by Remington Rand Univac Div., Sperry Rand Corp., for Tokyo Electric Power Co. The $2 million, large-scale computer will be used to control about 30 metropolitan region plants and substations in greater Tokyo. Data from the substations will be recorded on a master tape and the computer will calculate power requirements and peak loads.

A distribution agreement between General Precision Inc. and Mitsubishi Shoji Kaisha Ltd. includes an arrangement whereby the latter firm will be exclusive distributor in Japan for digital computers and other data processing equipment produced by General Precision's Librascope Div. GPL and Kearfott Div. products will also be handled.

Packard Bell Electronics Corp. has retained Kyokuto Boeki Kaisha Ltd. as sales and engineering representatives in Japan for the distribution of computers, analog-digital converters, and digital systems produced by its computer division. According to R. S. Bell, [illegible]sident, a substantial sales potent[illegible] exists.

A NEW ADDITION TO THE
SONAC LINE

POSITIVE ULTRASONIC LEVEL CONTROL

SONAC
ULTRASONIC SENSOR
DELAVAN

The components of Sonac (sensor actual Size)

Now, two new ultrasonic sensors, especially for level control have been added to the Delavan line of SONAC sensing and switching devices.

The single sensor system is recommended for liquid level control and the double sensor system for dry level control.

Control is maintained by installing the SONAC sensor through the wall of the vat, bin or hopper. When the oscillation on the face of the sensor is dampened or impeded by the material being sensed, the signal to the control unit changes, activating a relay.

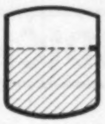


FIG. 1—LIQUID LEVEL (One Sensor)

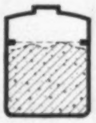


FIG. 2—DRY LEVEL (Two Sensors)

For level control, SONAC is accurate to .005″ and has a response time of 25 milliseconds. Performance of the sensor does not deteriorate with age.

The level control uses to which SONAC can be applied are virtually unlimited. It is not affected by the viscosity*, specific gravity, conductivity, or capacitance of the material being sensed. Temperature or pressure changes of the material do not alter its performance. False signals are eliminated because SONAC may be adjusted so as not to sense steam, foam, or vapors.

*Viscosity may affect response time.

Canadian Representative:

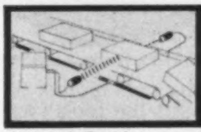
KNOWLES & FOSTER (North America) Ltd.

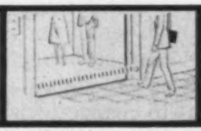
708 Terminal Bldg., Toronto 1, Ontario, Canada

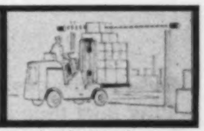
SONAC is extremely rugged. Sensors are type 304 stainless steel. The electronic components in the sensors are hermetically sealed and will withstand pressures to 2000 psi and temperatures from −425° F. to +450° F. They are immune to shock, vibration or mechanical damage.

The control is a compact unit 5″ x 5″ x 5″ and features transistor circuitry. Power consumption is one watt and the unit will operate in temperature ranges from 40° F. to 135° F.

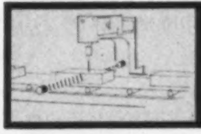
Here's how SONAC can be used for sensing and switching applications other than level control.

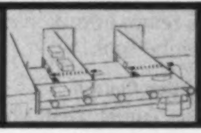


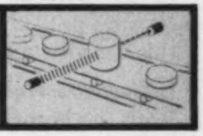




Automatic Counting **Door Control** **Overheight Signal**
Positioning **Package Routing** **Size Control**







There are dozens of applications for SONAC single and double sensor units. Let it go to work for you now, write:

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With the Fosmatic Turret Drill you know your costs before you start a job. Cycling time is pre-planned. The variables of speeds and feeds, the absolutes of dimensions are all pinned down in the tape. You even know tape preparation time—it averages one minute per operation from blueprint to punched and proved tape.

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Now a simple, 8-channel paper tape does the work of costly tooling. Table and saddle motions, spindle selection, speeds and feeds on the Fosmatic Turret Drill are numerically controlled by a General Electric Mark II system. Fosdick's own Fosmatic system controls spindle depth and traverse. These are numerical control systems you can depend on.

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The Fosdick Machine Tool Co., Cincinnati 23, Ohio

AUTOMATION

MAY 1961

Keeping It Going

Maintenance of production equipment comprises a major part of the success of an automated installation. By the very nature of most automatic machines they are usually considered as something special. Complexities of design and uniqueness of component applications often spell the differences in production capabilities that enable the manufacturing engineer to justify the expenditures for such equipment. If these capability potentials are to be realized, it is imperative that the equipment be maintained in good running order.

Because this class of equipment is likely to embody advanced control techniques, some companies have chosen to use specialists to maintain it. Hydraulics may be considered incomprehensible by all but hydraulics experts. Electronics and static controls may be relegated to engineering personnel.

In some cases this whole class of equipment is assigned to a special group reporting directly to the manufacturing engineering executives responsible for its specification and design. In other examples, outside firms contract for the maintenance job.

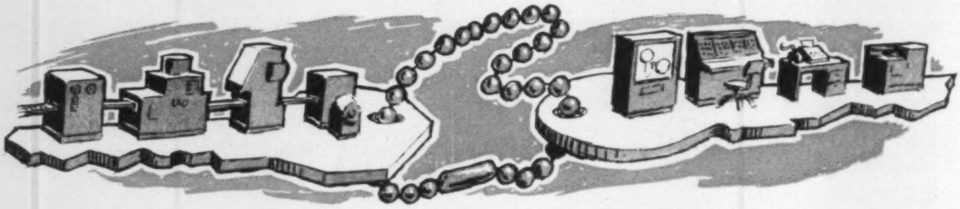
No one method works best for all, but one criteria of decision seems to predominate managements' choice of arrangement: Avoid split responsibilities. The desire to do this within the framework of various existing organization patterns has fostered the different techniques, and has roots in the co-operative attitudes of the various groups involved.

To avoid complications of conflicting classes of maintenance men, train your electricians to handle hydraulic and electronic gear. To avoid production shortages based on "maintenance inefficiencies" place the maintenance group under the production manager. To avoid equipment downtime based on "poor equipment design" reorganize so that maintenance is a function of the manufacturing engineering organization. To avoid internal squabbles of responsibility peddle the job to an expert in the field.

By whatever method is deemed most efficient, management must be assured of keeping its automation edge by keeping it going.

James C. Keebler

EDITOR



TOMORROW'S INTEGRATED OFFICES AND PLANTS

Automatic control in the plant and automatic data processing in the office have made tremendous progress. But even greater advances and problems are coming as these two developments are merged into larger over-all systems. Factors involved in this trend are worthy of careful consideration.

By GEORGE M. MUSCHAMP,
Vice President-Engineering, Industrial Products Group, Minneapolis-Honeywell Regulator Co., Philadelphia, Pa.

AUTOMATIC CONTROLS are experiencing an explosive growth. Industrial processes and their control systems are becoming larger and more complex. And this growth of automaticity is being paralleled in the office.

As exasperating as the area of automatic control is in its complexity—and it promises to become even more so—the challenges it offers provide it with a fascination for all who work in it. Every industry and most professions have a big stake in it.

I want to discuss here a subject that, in my opinion, is the most important single issue confronting not only those in automatic control but every industrial enterprise of any consequence. That is the eventual "marriage" of two massive developments—the automatic operation of the plant and the automatic operation of the office.

I firmly believe that the bringing together of these developments will constitute the greatest industrial event of this decade. As they now stand, the automatic controls in the plant and the automatic operations in the office are linked mainly through people. These arrangements are often loose and inefficient, but elusive as they are, they are a wide open target for automatic controls' big guns.

Each of these areas of automaticity—the office and the plant—has evolved over a long period. Each has had a complex and varied career of its own. And each has incorporated the latest scientific and engineering techniques that now provide the means for bringing them together. Automatic control people are the ushers of this colossal wedding.

Plant Automation

Let's look first at the plant. The staggering variety of manufacturing processes in all industries defies any simple classification. Automatic control people often divide all manufacturing into the continuous processes and the batch processes, but I have found

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This article is based on a paper presented at the "Fifth Conference on Manufacturing Automation" cosponsored by AUTOMATION, Purdue University, and the Manufacturing Engineering Council, April 1961.

considerable disagreement as to what degree of continuity is necessary in a process for it to be called continuous. Strictly speaking, there are few, if any, truly continuous processes.

It is also a gross oversimplification, of course, to think of all manufacturing as divided into the "wet" or liquid manufacturing processes and the "dry" or hardware manufacturing processes. However, there are distinctions between the two. In the so-called "wet" processes, such as those which are predominant in the oil and chemical industries, automatic control in the thirty years that I have known it has grown from relatively simple and often independently operating control systems to huge and complex systems measuring and controlling many variables. In these processes data is acquired on temperatures, pressures, flows, and the like in various parts of the process and quality or characteristics of a product both in the course of its production and at the conclusion of the manufacturing cycle.

Some of this data is transient. It is fed into control instruments, which do their work, and the data may be forgotten. Other data, however, are recorded for use in accounting, inventory control, non-automatic quality control, or engineering and management analysis. Although derived from the plant, they definitely are office data.

"Dry" processes, such as those which are predominant in the metals, food, textile, and paper industries, among others, share many of the characteristics of the "wet" processes. For example, they also use feedback control loops. Here again the measurements are of two kinds: Those which can be used within closed automatic control loops and have no further utility; and those which are used for further non-automatic control purposes, that is, for office or management purposes.

"Dry" processes such as found in the metal cutting and forming industries, the electronic industries, and other so-called "discrete" parts industries, often depart rather widely from the "wet" processes even though many have a high degree of production continuity. However, such operations as numerical machine controls, which embody automatic feedback principles, have much in common with the automatic control systems of the "wet" processes. One does encounter, though, in many metal cutting processes, discontinuities which characterize the process wherein many people are involved with taking and using data.

For example, the manual inspection of a batch of machined parts has two purposes. One is to provide data from which we can control the operation of the machine to produce acceptable parts. The other is to provide accounting or inventory data. The first purpose is served by a man-machine data or control loop including the machine, the operator, the inspector, the foreman, and sometimes many others. In the assembly of the parts even more communication or data passing among people may take place. Between these manufacturing operations and the business operations such as accounting, production control, and sales forecasting, data passing becomes a career for many people.

It appears then that throughout industry we are acquiring two categories of data or information about the production processes. One is the information that is automatically taken and automatically fed into control systems which automatically control specific processes in the plant. This information, for the most part, has little use beyond the requirements of the automatic control system. Therefore, people have little to do with this kind of information. Then there is the information about the plant that is automatically or manually taken and which goes to people for making decisions and taking actions. Often the actions are only to pass the information on to other people. It is perfectly plain that the more we enlarge the first category by creating more automatic data or control loops, the less data that need be given to people and the fewer decisions they must make.

▶ Office Automation

Let us look at the office where much of this information finally goes. It is not necessary for me to elaborate upon the degree to which electronic data processing has invaded office operation and the impact it has had upon the clerical and technical operations of business. It has been the means of extending the available work force to meet a work load that simply could not have been met manually. There are few large manufacturing plants that do not enjoy it in some degree for office work.

The tremendous technological changes that have taken place, and are continuing to take place in electronic data processing, are exemplified by the experience of Minneapolis-Honeywell. In the space of five years our company has developed two generations of computers of radically different design, each of million-dollar size. The development of such equipment represents enormous capital outlays and expenditures of scientific and engineering talent.

To simplify our discussion, let us consider office processes as falling into two large classes. One class of office process is that whose final product is primarily information. The other class of office process is that in which the information is incidental to the manufacture of some real product.

In the first category—the information office—fall all of the record-keeping operations of insurance companies, banks, and nonmanufacturing enterprises of all kinds, as well as research testing of industrial laboratories, engine test laboratories, and missile ranges. This category is not of immediate concern in the coming wedding of plant and office because no physical product is involved.

What does concern us is the second category—the real product office—which embraces all office operations of all the manufacturing plants referred to in connection with automatic control in the plant. To some degree, testing operations can be included.

Our concern is with the *whole* manufacturing process for products. This includes the manufacturing equipment, its immediate automatic controls, *and* the data acquisition, processing and computing equipment in whatever departments of the organization it may be lodged. Less and less, it seems to me, will there be a clean line of separation between what is automatic control equipment in the plant and what is automatic data processing equipment in the office. The immense challenge before us is the minimization of the intolerable and costly overlapping which surely will occur if we continue the separate pursuit of plant and office automatization.

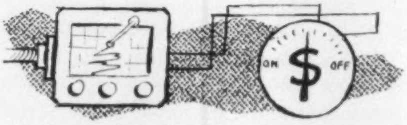
Evolution of Integrated Control

What is now possible, if we face up to it, is the merging of plant and office functions. We can reorganize the paperwork, which is the present end product of most automatic office equipment, so that the information, in addition to serving as a record, can be fed automatically into the plant control systems as required. We can automatically acquire, from the process, the information needed for automatic control of the process together with the information needed for accounting. We can automatically feed the necessary information back to the process for automatic control. We will then have more automatic parallel operations in place of the present man-machine serial operations.

This has been characteristic of the evolution of control systems. First you measure. Next you record, usually collecting more records than are needed—records that are used by people who adjust the process and so make man-machine control loops. Then you automatically control, with parallel recording, gradually eliminating all but the records required for monitoring or for the future. The process goes on in ever-widening loops.

This same kind of evolution will occur in the joining of office and plant operations. Presently, the targets for manufacturing operations are set through office operations with respect to the factors of profit, cost, quality, delivery, and production control. However highly mechanized these office operations have become, their output is now primarily designed for the use of people, not for directly feeding into plant automatic control systems. The intervening people now adjust the plant automatic controls.

Bit by bit and with increasing acceleration, ways will be found to join automatic office equipment to automatic plant controls. The development will be impeded by the fact that there is relatively little standardization among companies as to how things are done in this area. However, we will learn how to make these connections on an experimental basis. First we will simply record and observe their effects. Then we will allow them to automatically control with parallel recording of monitoring information, and finally we will minimize the information gathering step, as the automatic control proves itself.



Built-In Financial Controls

Few companies today attempt to operate without some means of market forecasting. These predictions are the inputs to the production control mechanism. The production control mechanism goes on to provide parts breakdowns which form the demands on the manufacturing departments. Cost information is generated and related to prices—an operation that can be mechanized in varying degree. Compilation of salary, wage, and other information may be done automatically, including various "control" reports.

Anything which purports to be a "control" is of consuming interest to us. It must, however, contain performance versus a criterion or it is not a "control" at all. If it has these, then it has the elements necessary for *automatic* control. For example, if a product is to yield X per cent gross profit and the automatic data processing equipment determines that a given product line is not meeting that target, Presto, a switch can shut down that line. Ridiculous? It would be surprising how many corporate directors would rush to buy such a device if they could be sure the figures were reliable. Sales contentions that an unprofitable product helps sell products that are profitable would be more objectively examined.

Or instead of shutting down the line, perhaps the switch could electrify into action the department foreman, an industrial engineer, or the design engineer. Think of all the many things that could be done with just this profit-by-product-lines criterion.

Suppose, for example, that a continuous refinery under full automatic control is capable of turning out, dependent upon the respective adjustments of the control instruments, two different products from the same crude input. Suppose, also, that these adjustments are controlled automatically from a computer which, in effect, possesses a "profit switch." Suppose, further, that the market situation is such as to make the two products equally acceptable. Then, obviously, the "profit switch" could be actuated to set the control system in the refinery so as to make the profitable as opposed to the unprofitable product. This can be paraphrased for several industries in which the attempt is now being made to incorporate over-all economic factors in automatic plant operation.

What is significant about such operations in terms of the wedding of plant and office is that market and economic information processed in computers is directly applied to the automatic control system of the plant.

This business will not be as simple as the "profit switch," but in the entire interaction of the elements of an enterprise, the operation will consist of a multiplicity of such operations automatically programmed and monitored by people as they properly should be. While control systems for a whole enterprise can become quite complex, they nevertheless can be built step by step. A case in point is that of a large metropolitan electric company which serves several million users with a system of great complexity. It soon will have our on-line digital computer to help it solve the problem of producing electricity at minimum cost.

Each generator in each generating station has a machine control system for keeping constant the characteristics of its output despite variations in load to meet changing power demands. This is done by varying the supply of steam or hydraulic power to the turbine from a source which has its own control system. Also, generators in a station usually have different efficiencies requiring that, for optimum economy, the load should be apportioned among them according to their relative efficiencies at different levels of load. This is the station control system. Furthermore, the stations also will vary in over-all efficiency and be miles apart, introducing line loss factors. The relationship of all the factors involved in such a system is so complex that the solution to the economic dispatch formulas and the automatic adjustment of the network, station, and machine control systems to maintain over-all system efficiency at an optimum, lies in a general purpose digital on-line computer.

There is another complication which enters the picture. Power networks are interconnected so that one company may buy or sell power from another as demand dictates. Thus, a half-dozen or more other networks may be supplying power to a network or receiving power from it. Whenever this happens, further variables are introduced into the system control, involving, in addition, intercompany economics since obviously there must be an accounting of the power produced by one company and used by another.

The on-line digital computer, whose primary job is automatically directing the control system, performs a secondary function. That is the obtaining of basic data for intercompany billing of the delivered power. The significance of these economic and business operations in the automatic control system is the bringing together in a fully automatic way the things which have in the past been regarded as separate plant and office operations.

It is impossible at this stage to specify the exact degree to which the automatic operations of office and plant will merge. I do not contend that there will not also be separate and independent office or plant systems. So long as they are dealing respectively with information or data that in amount and kind has little in common, there is not much point in merging them except for machine economy.

▶ Linking Remote Locations

It is typical of the enlarging loops of automatic control and data processing alike that the communication function is becoming increasingly important. In the power control system just cited, the generating stations and the tie points with adjoining networks are many miles apart. This requires communication between the various measuring and control points and the central control locations—in this instance, telemetering over telephone lines. In the operation of pipelines, the state of development of telemetering and remote supervisory control systems is so high that many large stations are completely unattended.

Thus, in practically every field telemetry is rapidly making possible the joining of operations formerly linked by people or not linked at all. Where wire connections are not possible, in cases such as airborne and other vehicular systems, radio will have an important place. The frequency spectrum is being exploited from one end to the other for industrial communication purposes—from d.c. control systems to microwaves and above. The opening by the Federal Communications Commission of frequency bands above 10,000 megacycles for private communication systems now makes it possible for industrial firms to have their own networks for data links, automatic control, and voice. All of this communication activity will accelerate the joining of office and plant systems.

▶ Role of Top Management

No matter how passive a role top management plays in these two evolutions of automaticity, that in the office and that in the plant, each will evolve as economics dictate. As they meet, however—and they are now starting to do so in a significant way—they will not necessarily mesh in a logical pattern. It is already apparent that, in the absence of a deliberately planned program, the chance is rather remote that the automatic plant controls and plant information gathering equipment will be compatible with the office data processing equipment. This is not surprising when one recognizes the wide gamut of systems and designs of equipment now available in both areas.

But management can not afford to do nothing. It will be faced with some costly improvisations if it does not have an over-all plan to insure compatibility. How does management get this insurance? There are two efforts looming up in answer to this. First, some managements are recognizing the wide scope of these movements by establishing upper echelon committees or task forces under a corporate officer to study and plan the acquisition of automatic equipment. Secondly, equipment manufacturers are supplying more and more systems engineering and are recognizing the need for compatibility by providing "common language" input and output signals for the various pieces of equipment and by supplying single source responsibility for systems. It was in recognition of this trend that our company set up a division devoted exclusively to advanced systems engineering.

Management and engineering consultants will become involved in this evolution to a greater or lesser extent depending upon the degree to which an enterprise can provide these services from within. This has been the traditional role of the consultant where plant design, construction, finance, and organization have been concerned. There appears to be no reason to expect this relationship to change. But where these consultants in the past have been specialists in one area or the other, they, too, will need to provide several services collectively. I know of several formerly pure accounting firms now employing operations research departments.

▶ Engineering the Systems

The many problems of joining the plant and office are large. Ironically enough, they do not arise from a basic lack of machine techniques, but from a lack of process knowledge which, in the office, means procedure knowledge. It involves also a vast lack of procedure standardization in both the plant and the office, calling for special solutions that are often uneconomic. That is to say, the differences in the ways that different companies do things prevent use in a second plant of the system and application engineering carried out at a first plant.

It is upon this problem area that operations research has made an assault with varying degrees of success. Those, who have tried operations research and found it wanting would, I feel, do well to ask whether it was this approach which failed or whether they were not asking operations research to do some things which should have been done by other means. Common sense systems or application engineering in some cases might have been the answer.

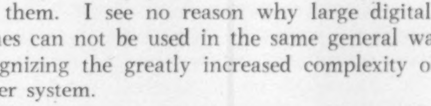
One can not perform either the user's role or the equipment manufacturer's role in this evolution without the most advanced systems engineering which applies to the problem. This means using mathematical models where they are applicable. It means using dynamic analysis and servomechanisms theories where they are justified. It means using common sense when none of the sophisticated techniques apply.

In my opinion, there have been two erroneous impressions created in the art. One is that complete mathematical models are widely applicable at present and widely used. It is true that a great amount of study and theorizing and some experimentation are taking place. Yet we are not often able to provide accurate mathematical models for real processes nor able to provide quantitative data for such models. This is not to disparage the effort which I sincerely hope and expect will continue, will accelerate, and will succeed.

The second is the impression that one can not advantageously use data processing equipment or computers without complete mathematical models. There are many functions of processes that have been well known that required too much time and manpower to be handled manually but which can now be advantageously handled by computers. There are many functions not known to us, as specifically as the mathematician might like, that can be handled by computers.

A good example is the three-mode controller. Either in its pneumatic or electrical form, it is an analog computer. It has been in wide industrial use for twenty-five years and can be tuned or adjusted to the process whose specific quantitative characteristics are not known. I happen to know that these were originally developed without the benefit of servomechanism theory or much mathematical knowledge of the process. Their basic contribution to the development of industrial processes is history. Many processes could not operate without them. I see no reason why large digital machines can not be used in the same general way by recognizing the greatly increased complexity of the larger system.

What I want to emphasize strongly is that we should not be frightened because there is so much that we do not know. We should realize we know enough to effect vast changes if we do so studiously. Study does not mean mathematics alone. I believe that any presently successful enterprise can find enough qualified personnel within its organization to make an impressive start in this field, relying, if necessary, on outside assistance for help in specialized areas. If we did nothing more than broaden the horizons of our industrial engineering departments, we could make tremendous strides. Too many of these departments have been limited to the role of tool design or specific process or method formulation and have not been given enough breadth of scope in their activities. It is management's job to correct this.



▶ Appropriate Information Use

Since we are dealing with the production of real products, and the use of information in the production process, let us orient our information to manu-

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GEORGE M. MUSCHAMP, as vice president-engineering for the Industrial Products Group of Minneapolis-Honeywell Regulator Co. is responsible for integration of product programs and the technical evaluation and planning of long-range needs in industrial process and laboratory instrumentation, data acquisition and reduction systems, and computer-directed control systems. He has spent more than 30 years in the instrumentation industry, all of it with Honeywell. Other assignments have been as patent engineer, patent attorney, assistant divisional general manager, and manager of engineering.

Mr. Muschamp attended Drexel Institute of Technology and is a fellow of the American Society of Mechanical Engineers. He is the author of numerous articles on various aspects of engineering and instrumentation.

facturing. We have four sets of information:

1. That which is now directly incorporated in manufacturing automatic control loops and has no other use.
2. That about the manufacturing process which is either automatically or manually taken and which has further use by the plant operators and others.
3. Business and technical information generated within the enterprise.
4. Business and technical information generated external to the enterprise.

The first and second categories of information relate in a way that is obvious but terribly important. If information has no use beyond its function in an automatic control system, then we should stop collecting it, once the automatic control system is installed. Obvious as this is, it is surprising how often we fail to recognize that the man-machine loop has been replaced by the automatic feedback loop and the man no longer needs nor can use certain information.

We do need the second category of information about a process even when it is under automatic control. An operator needs certain performance information for monitoring the whole effort. Quality control, engineering, accounting, and various levels of management need information. A transitional step in bringing plant information into the office system is automatic data collection.

Business and technical information peculiar to the individual manufacturing operations is a mixed bag. Part of this data may be automatically read *out* of the plant, processed with other data and then be automatically read *into* the plant. If we want automatic control, it is this part that has to be carved out of a mass of other data which may exist for other purposes.

The fourth, the external category of information, is usually not susceptible to inclusion in the automatic control system unless we happen to be considering one plant of a multiplant enterprise. In that case, our system may be extended to the whole enterprise.

In summary, plant automaticity has reached a high state of development. Office automaticity is rapidly approaching the same point. We are on the threshold of a colossal wedding of these two dynamic movements in company-wide automatic operations. New developments in communications will accelerate the movement and systems engineering will play a leading role. The effect of this wedding will be to produce more goods, to provide more jobs better suited for people, to require more education to fit people for these jobs, and for the present it will mean more work for management to economically bring this off as a union and not a collision.

are you stuck?

Since its inception Automation has helped increasingly in the solution of hundreds of widely diversified practical problems in making manufacturing operations more automatic. Regardless of the character of the operation or system being developed, somewhere in industry a similar problem has been solved and, very often, equipment is available from reliable builders or suitable techniques are known to specialists.

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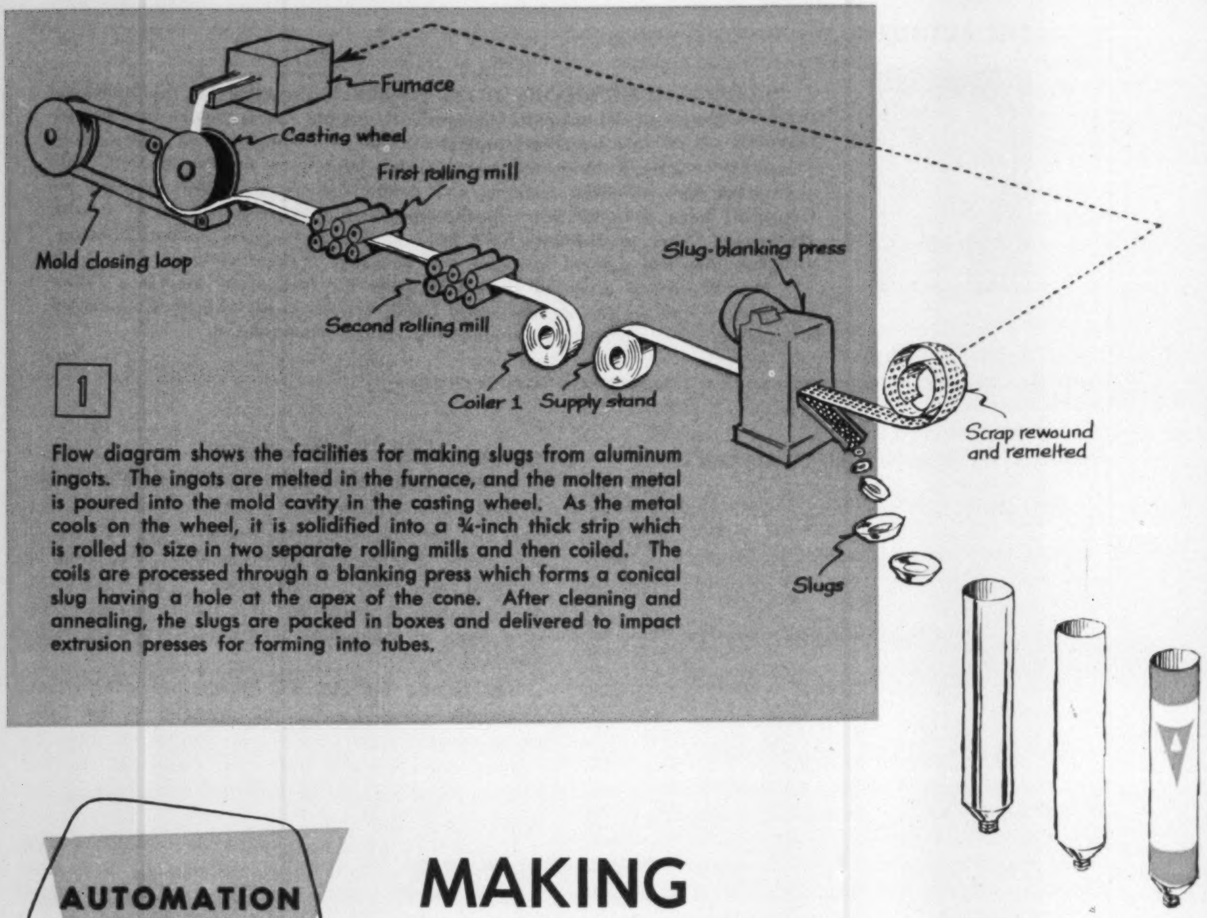

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Flow diagram shows the facilities for making slugs from aluminum ingots. The ingots are melted in the furnace, and the molten metal is poured into the mold cavity in the casting wheel. As the metal cools on the wheel, it is solidified into a ¾-inch thick strip which is rolled to size in two separate rolling mills and then coiled. The coils are processed through a blanking press which forms a conical slug having a hole at the apex of the cone. After cleaning and annealing, the slugs are packed in boxes and delivered to impact extrusion presses for forming into tubes.

AUTOMATION TODAY

MAKING TOOTHPASTE TUBES

FROM ALUMINUM INGOTS

DAILY output at the Hawthorne, N. J., plant of White Metal Mfg. Co. is approximately 750,000 collapsible aluminum tubes for use in packaging toothpaste, shaving cream, and pharmaceutical products. To obtain this production volume, the company recently completed an automated facility which includes three continuous processing lines for converting aluminum ingots into finished tubes. The first line integrates a continuous casting system for making aluminum strip from ingots with a two-stage rolling line for finishing the cast strip to size. The strip is then processed through a second line where cone-shaped slugs are blanked from the strip, cleaned, and annealed. A third continuous line then impact-extrudes the slugs into collapsible tubes and applies a lithographed decoration in two or more stages.

The new facility climaxes a unique program of international co-operation between White Metal, an independent aluminum fabricator, and its principal supplier of primary aluminum ingot, Aluminium Limited of Canada. The rotary casting process, used in converting aluminum ingot to continuous strip, was developed in Canada and England during the last five years by Aluminium Laboratories Ltd., research arm of Aluminium Limited. With the new facilities, White Metal has been able to integrate its operations so that it can produce finished, decorated, and capped aluminum tubes—ready to be filled—from primary aluminum ingot with minimum manual handling.

The accompanying illustrations present highlights in the process of making toothpaste tubes from aluminum ingots. Other types of containers can be made by the process, and the company is confident that it will open new markets in all impact extrusion fields, including tubes, cans, containers, and extruded shapes.

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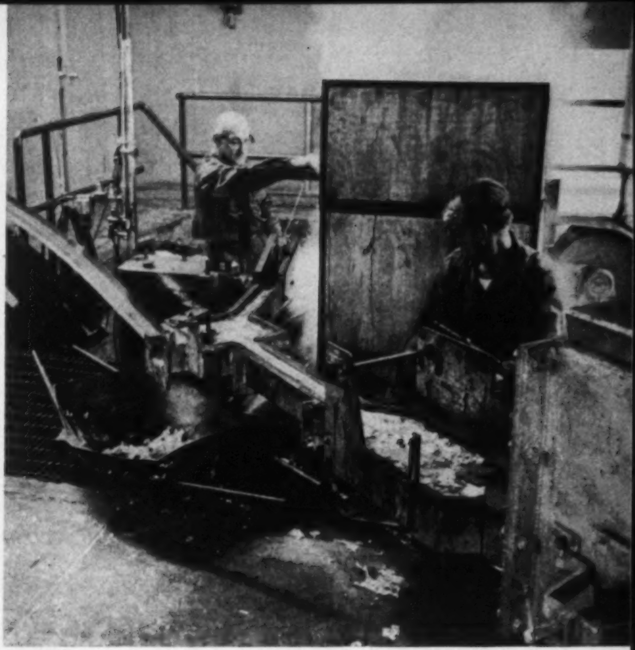
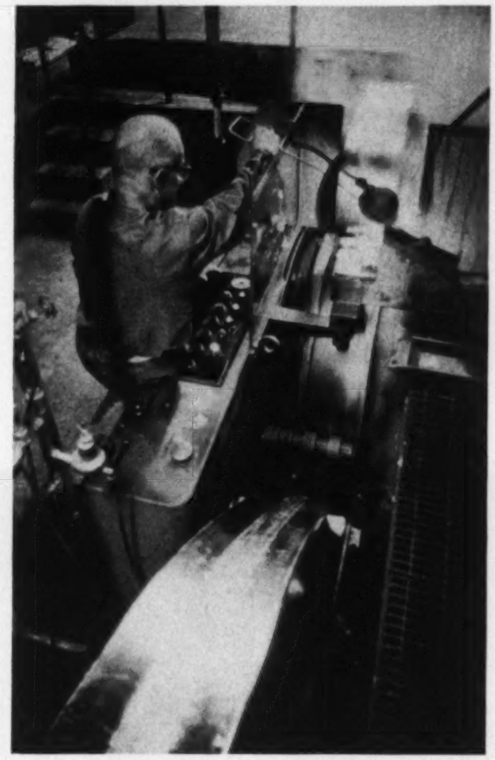
The beginning of the continuous casting line is shown. Aluminum ingots, having a purity of 99.9 per cent, are loaded into a 7000-pound capacity gas-fired furnace, right foreground, and melted. The molten aluminum is then drawn from the furnace through a system of troughs, center, and fed to a slowly revolving casting wheel, background. The casting operator in the background controls the flow of molten aluminum to the wheel by means of a manually operated gate in the trough.





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This view shows the aluminum strip, foreground, emerging from the casting wheel. The wheel is 40 inches in diameter and contains a mold cavity which is 8 inches wide and ¾ inch deep. The top of the mold is continually closed by a steel belt loop shown in the background. The molten metal flows into the mold cavity and is cooled by water as the wheel turns. The speed of the casting machine controls the speed of the two rolling mills and the coiling stands.

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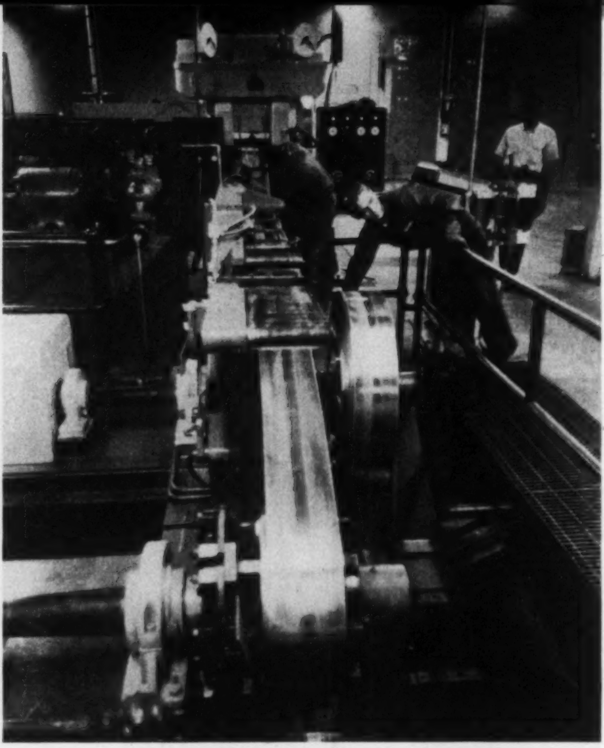
From the casting area, right background, the ¾ by 8-inch strip is conveyed through the first rolling mill, center. Both rolling mills are of the same design and reduce the strip to thicknesses varying from 0.150 to 0.250 inch. The final strip thickness is dependent upon the product being made from the blanked slugs. Controls at the side of the mill are used to adjust the rolls during operation.



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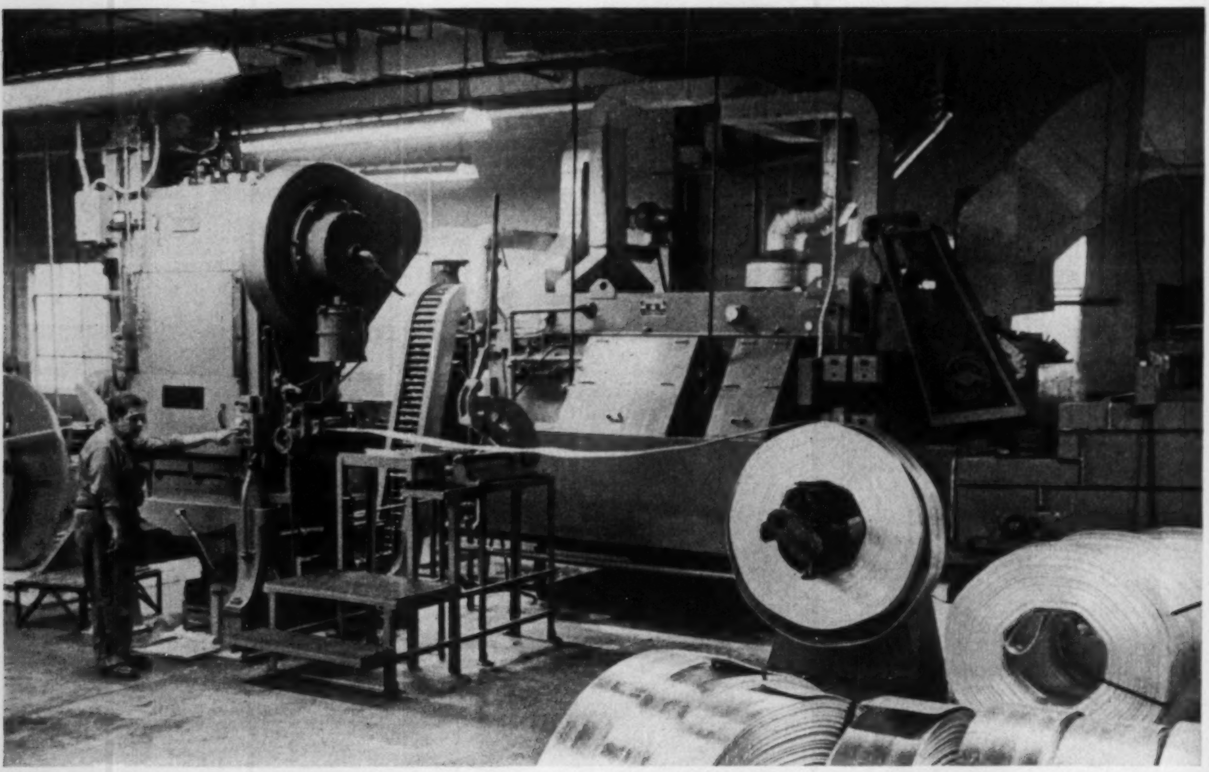
After passing through the second rolling mill, center background, the strip is alternately coiled on the two coilers in the foreground. When about 1000 pounds of strip has been coiled, the strip is automatically diverted to the empty coiler. Then the full coiler indexes the finished coil out of the line where a motorized hoist can pick up the coil and move it to temporary storage preceding the blanking line.



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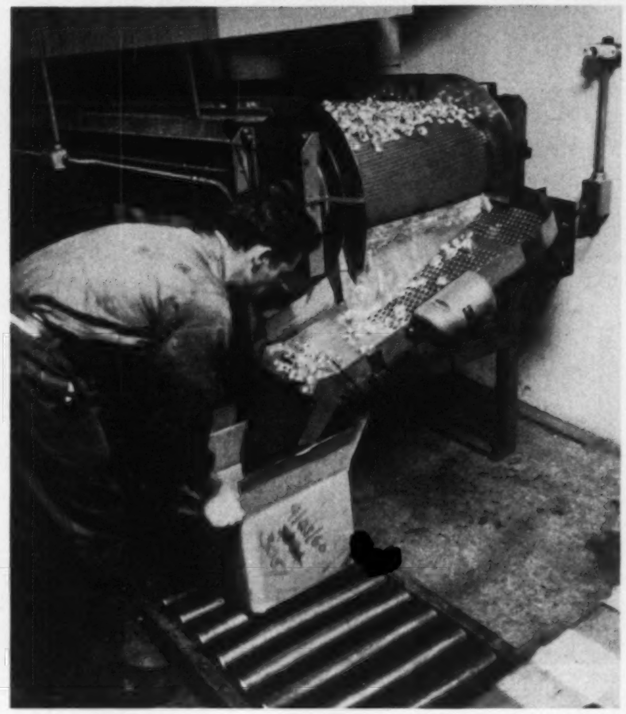
A 100-ton press, left foreground, blanks out slugs from the coil strip at a rate of about 25 to 30 pounds of slugs per minute. The slugs drop into an elevating feeder which lifts them to a hopper of a washing machine, center. After being cleaned, the slugs are conveyed through an annealing oven, right background. The scrap strip from the blanking press is coiled and then remelted in the furnace along with aluminum ingots.



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After annealing, the slugs are cooled on a mesh conveyor which empties them into a vibrating trough. From here, the slugs are loaded into cartons holding 50 pounds of material and either moved to impact extrusion presses in another part of the plant or shipped to other plants in Hoboken, N. J., or Indianapolis, Ind.

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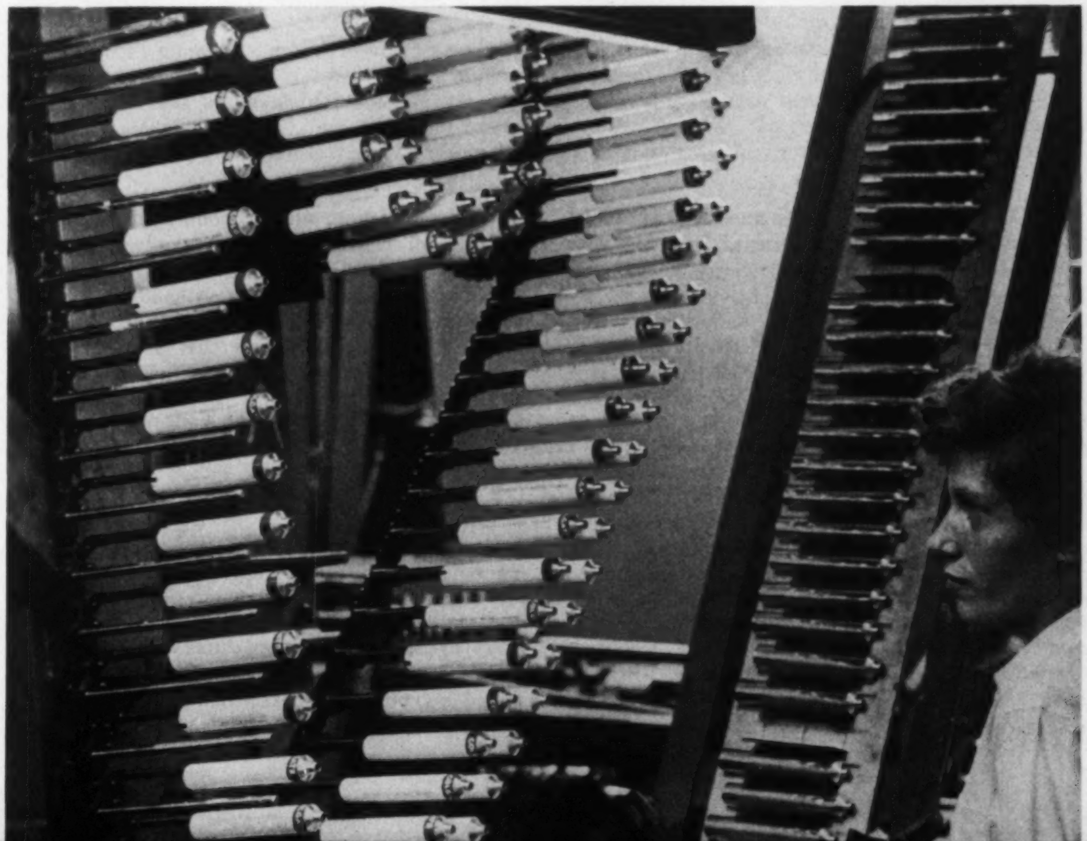
The slugs are impact-extruded into toothpaste tubes and then conveyed to finishing lines for lithographing and inspection. In this view, the bare extruded tubes can be seen on the conveyor in the right background. On the left can be seen the progressive stage of lithographing in which the tubes are first coated with white ink and then imprinted with product data in color. In addition to being used to produce collapsible tubes for toothpaste and medical ointments, the slugs can also be processed into rigid aluminum containers such as aerosol cans and condenser cans used in the electronics industry.



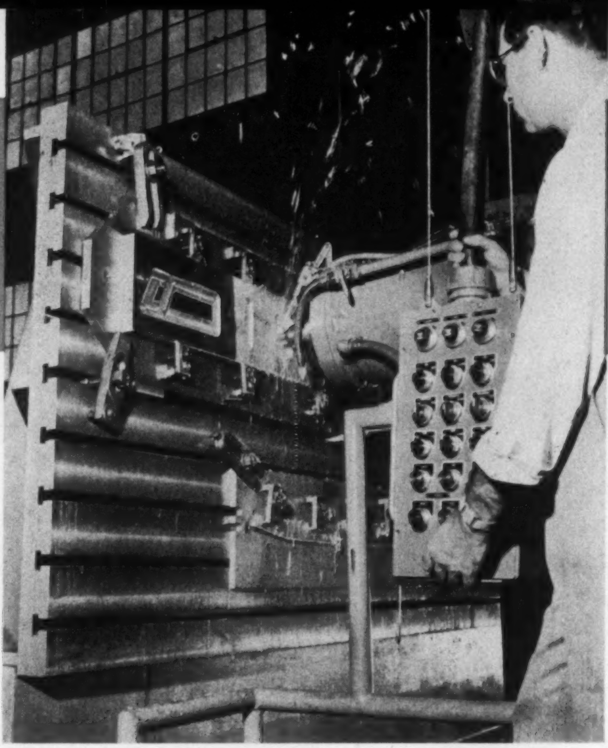


Fig. 1—Magnetic tape is used to control this Giddings & Lewis profiling machine at the San Diego plant of Convair, Div. of General Dynamics Corp. The cutting-head tool receives 200 position signals per second from the tape for each axis of movement. Each signal can command as little as 0.000125 inch of tool-position change, making possible curves and intricate shapes of great accuracy.

CONTROLLING WITH MAGNETIC TAPE

By D. W. HALFHILL, Cost Reduction Engineer, Ampex Instrumentation Co., Div., Ampex Corp., Redwood City, Calif.

CONTROL SYSTEM engineers must design systems which perform needed functions with the best possible cost and service to the user. In meeting these objectives, it is necessary to use accumulated skills and knowledge and to study new devices and techniques which will do the job better. One of these techniques is the use of magnetic tape as an information storage medium in control systems. Some prime advantages of magnetic tape are pointed out in box entitled "Attributes of Magnetic Tape."

In the evaluation of any kind of automatic control, it is difficult to specify exactly what rules to follow. Certainly it is not difficult to determine the cost of automating once the problem is defined, equipment specified, and bids have been received. But to determine what the payoff period is and what factors should be considered in this payoff is a little more nebulous. A good place to start is to analyze the situation without automation. It will help to have answers to these questions: 1. What does it cost to perform the function without automation? 2. With automation, what economies can be expected in terms of reduced waste and spoilage, increased productivity, better customer service, reduced inventory through more expeditious handling, and better control of the entire process?

Additionally, other factors that should be considered include: 1. Increased plant investment, taxes, and interest. 2. Maintenance costs. 3. Possible need to change processes or retrain personnel.

Economic Factors

No innovation in commercial production, including industrial control, is justified without a reasonable payoff period. The first cost, plus maintenance, depreciation, and plant investment expenses must be offset by savings. A most direct measure of such savings is in dollars. Sometimes, however, needed skilled manpower cannot be obtained at any price for certain critical jobs. This situation has pre-

Magnetic tape has become an indispensable element in automatic control systems where flexibility in handling a high density of data and speed of data input and retrieval are important. Technical aspects of magnetic recording systems and the application of such systems to industrial control problems are discussed by the author.

vailed in the aircraft industry for some time. Automatic control, therefore, is a means for making skilled manpower go further.

Dollar savings have been demonstrated in many industries, but the actual figures have been and still are considered private company information in most cases. Automatic control has proved so successful that speed of changing to automation has been accelerated by many of those who have adopted it. Without releasing exact figures, many companies have effectively told of their successes with automation by continuing to increase its use. However, there are several points to consider in working out an effective change to automation.

A complete analysis of the control problem is the first step. In a few cases, automation has advanced too rapidly, with disappointing results. An analysis involves a common-sense evaluation of the possible savings that can be made. Processes which are already nearly automatic may not result in significant savings. Examples of this can be found in the automobile industry, where elaborate production lines produce automobile engines. The production volume is so high in these cases that extremely high-quality mechanical program-control equipment can be justified.

Greater savings can result in industries where expensive automatic machinery cannot be justified. Magnetic tape controlled equipment, *Fig.* 1, may provide the necessary precise controls for such automatic operations. Examples of this are in the aircraft industry where complex parts are manufactured in quantities of a few dozen to several hundred. It would be impossible to produce many parts now used in military aircraft without tape controlled machine tools—at least in the quantities that they are required.

▶ Design With Care

It is desirable to break a large, complex process into groups of operations, each with its own control center. This permits better continuity of production, especially when parallel systems are provided. If one element of the entire system malfunctions, it can be taken out of service for repair, while the remainder of the system can

ATTRIBUTES OF MAGNETIC TAPE

- Magnetic tape furnishes a stable memory which can be used immediately after recording. Faulty data can be erased from a tape, and correct data recorded in its place. Information recorded on a tape may be played back from one to 10,000 times without deterioration.
- Since output of a magnetic tape is in the form of electrical signals, data recorded is in a dynamic energy form that can be used directly. Signal output in most cases is identical to signal input.
- Magnetic tape has a capability of recording signals varying from essentially steady-state values up to 100,000 cycles per second. In some cases the upper limit may be higher for the television industry is now using special equipment that will record up to 4.5 megacycles.
- Delays in tape playback can vary from a fraction of a second to hours and even years. Regardless of delay period, data on tape is recreated in its original form.
- Versatility of recording methods using magnetic tape allows data to be handled in different modes with high degree of accuracy and repeatability.
- Up to 32 parallel tracks of data can be recorded on 1 inch wide tape, permitting the simultaneous recording and playback of many different parameters with close time correlation of all tracks. Time and frequency sharing by means of multiplexing on individual tracks can further increase the number of simultaneous recordings that can be made with close time-base correlation.

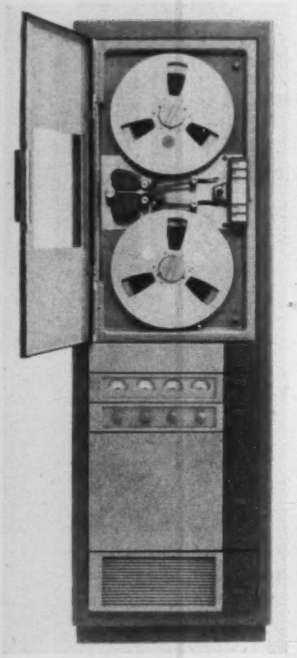


Fig. 2 — Analog magnetic tape recorder built by Ampex can provide up to 14 analog tracks or up to 32 digital tracks. The equipment has a capability of recording up to 1000 channels of multiplexed data on one analog track and can be used for direct, FM-carrier, pulse-duration modulation, or digital recording.

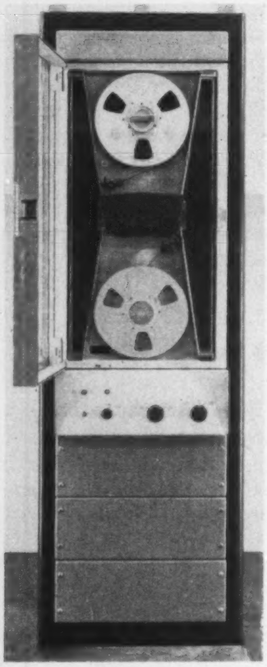


Fig. 3—This Ampex digital tape recorder was developed for use with high-speed computers, data recorders, high-speed printers, and digital converters.

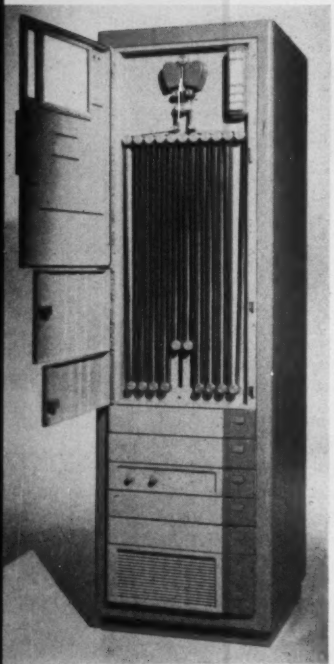


Fig. 4—A continuous loop recorder can be used for repetition, anticipation, and time delay.

operate normally. Parallel systems give support to each other to permit routine maintenance and continuity of service through such periods of maintenance.

Designers of any electromechanical system must face the prospect of intermittent control failures. Careful design will minimize the possibility of system failure, but nevertheless, much thought should be given to the consequences of a failure either in the control system or the system being controlled. All elements of the system must be fail-safe, that is, they must operate in a manner which would cause either shutdown or an action resulting in minimum disruption of the system. Consideration should be given to emergency control by human operators should the system fail completely. An example of this might be a petroleum refinery process, where the plant would be destroyed without some kind of control for an extended period of time and where the process must be continued to prevent costly restarting operations. This fact may seem self-evident, but there have been enough cases where such simple facts have been overlooked that it does well to repeat it.

Not only must the control system be carefully analyzed, but the machine tool, assembly machine, or process should be carefully analyzed to be sure that it is capable of control. To apply precise magnetic tape control equipment to a machine tool implies that the machine will accept and respond to control signals with sufficient accuracy to achieve the end result. Machines may have to be improved to meet this requirement.

There are certain technical pitfalls to avoid when using magnetic tape equipment as a memory device. For example, never forget that in any automatic control system, a memory element—whether magnetic tape or other device—exhibits a certain transfer function. Introduction of flutter when combined with resonances in another part of the system may result in undesirable performance. These problems can be overcome by proper design.

Secondly, many types of magnetic tape handlers are available, and usually one is better for an application than another. There are reel-to-reel machines for either analog or digital applications, or a combination of both, *Fig.* 2 and 3. For special applications there are also loop recorders capable of continuous operation in many different modes, *Fig.* 4. Many times, a first choice made for a particular application is not the best when all factors are considered. It is strongly recommended that the advice and assistance of persons intimately acquainted with magnetic tape capabilities be consulted to be sure that the best use is made of the equipment. All manufacturers of such equipment have application engineering staffs who are capable of assisting in this manner.

▶ Typical Systems

A complete control system includes the control device, the machine or process controlled, and the means for developing a program.

Simultaneous control of a number of functions requires at least one data channel for each function controlled. Some systems use a pulse-counting technique in which one channel is reserved for forward motion, the other for reverse motion. Each pulse is a signal to move a discrete interval along the control path. This method is simple and relatively easy to apply but introduces errors if pulses are lost. This possibility is virtually eliminated by keeping the pulse density low on the tape and by recording the tape to saturation, thus insuring a maximum playback signal.

Another type of control using magnetic tape involves digital recording of data. For multiaxis control, raw digital information calls for discrete movements of the tool, which might leave undesirable ridges and marks in smooth contours. For this reason, digital systems are combined with an analog interpolating device which allows smooth transitions between digital points. The system has the advantage of absolute accuracy without need for synchronization at any time. However, it is more complex than the other systems.

Still another type of control is direct-operator programming. This method may be particularly advantageous in small shops where medium-size runs of parts will be encountered. It can be used to advantage where machine time can be spared for preparation of the program.

A method of preparing such a program is to have a skilled operator go through the movements required for making the desired part. The tape may be run at a slow speed during the recording process. With certain kinds of systems the program may be edited to remove waste motions. When the recorded tape is played back in the control system, the machine responds as if it were controlled by a human operator. It may be run at either the same speed or at a faster speed to increase production rates. A low-cost magnetic-tape machine may be used for this purpose because the tape is usually played back on the same machine that creates it. If the same transport, guides, and heads are used, interchannel timing errors are kept to a minimum, and greater precision can be obtained with less expensive mechanical features in the tape equipment.

Other systems involve recording of continuous analog control signals for multiaxis control from computer-prepared programs. Such systems exhibit high accuracy for extremely large and complex shapes.

▶ Duplicating Tapes

Program tapes for complex parts are valuable. It is risky to take the only copy of such a program into a shop where the tape may be damaged inadvertently. Copies of master tapes are easily made.

The easiest way to prepare copies of analog tapes is to run the master tape on one playback machine and feed the electrical signals into a second recording machine. Past experience has indicated that best results for analog tapes are obtained when both tapes are run backward. The reason for this is quite simple. In any electronic circuit designed to handle

BASIC MAGNETIC TAPE SYSTEMS

COMMUNICATION between technical fields is enhanced if a clear understanding of commonly used terms exists. Some common terms used in magnetic tape technology are:

Control. In magnetic tape technology this means a process of storing information in such a way that it can be used to control an operation or a process. Tape control can be of a nonfeedback type such as a predetermined program used to operate a machine tool. In this case, a tool may be directed to follow commands which are generated by a controller from information stored on a tape. A feedback control system, on the other hand, may operate by producing information to be stored on a tape. This information is later used to modify the action of the process to bring about a desirable condition. Data-logging and processing operations may be combined with such a control operation, resulting in operating records as well as the control function.

Analog recording. This term is generally applied to recording of continuous, nondiscrete measurements and the reproducing of these signals in a continuous nondiscrete electrical form. The reproduced signal is an electrical analog of the original function. As such, it is subject to errors which include those of the original detector, the tape recording and playback process, and the output device using the reproduced signals.

Digital recording. This method involves preservation of information in discrete or quantized forms. Analog information must be converted to digital form by an analog-to-digital converter. The information is then in the form of discrete pulses, or signal level changes, which exactly represent the digital numbers or characters to be recorded. On playback, this information may be used directly in digital form by all-digital systems, or may be converted back to analog form.

The errors which are possible in a digital system are those of the detector, the analog-to-digital converter, and the digital-to-analog converter (if used). Ordinarily, errors introduced by recording and playback of the tape are negligible. Such errors, if they exist at all, are produced by "drop-outs" (loss of data due to imperfections of the tape itself) or are due to dust particles which might interfere with perfect reproduction. For this reason, accuracy of digital systems is usually much higher than that of analog systems.

In any magnetic tape system, the bit packing density is defined as the closeness with which bits may be recorded on a single tape. Newer digital transports can record 555.5 bits per inch. For example, a 2400-foot roll of ½-inch wide magnetic tape can contain 5 million characters, which is equivalent to the data stored in 60,000 punched cards or in 50,000 feet of punched tape. The data transfer

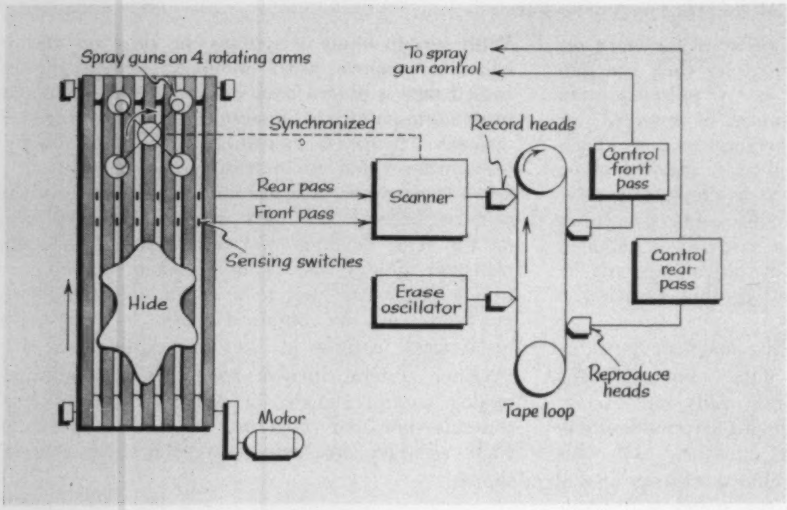

Spray guns on 4 rotating arms
To spray gun control
Synchronized
Record heads
Control front pass
Rear pass
Front pass
Scanner
Sensing switches
Control rear pass
Erase oscillator
Hide
Reproduce heads
Tape loop
Motor

Fig. 5—A continuous loop recorder is used to control the activation of spray guns in this hide-spraying system. The outline of a hide is sensed by metallic fingers projecting through a series of parallel conveyor belts. Signals from the sensing switches are recorded on a magnetic tape loop through the scanner and record head. Reproduce heads read the signals at the appropriate time and initiate spraying action. The system ensures that expensive chemical will be used only when the hides are under the spray guns.

a wide range of frequencies, one end of the spectrum is shifted in phase by a different amount than the other end. This results in "phase distortion" which has the effect of distorting wave forms without actually changing the magnitude of the various frequencies represented. A small amount of such distortion occurs during the recording process and, of course, would occur during any re-recording of the same signal.

If the tapes are run backward, phase distortion, in effect, cancels itself for every other succeeding tape copy. It is not surprising to find that second-generation copies are as good as the originals in terms of phase characteristics. It is not necessary for each manufacturer to have copying equipment in his plant. Reproductions may be made by anyone who has suitable magnetic-tape-recording equipment.

▶ Tape Applications

Process Control. Processes usually require a regulating or governing type of control. One type of process is that in which the condition of the mate-

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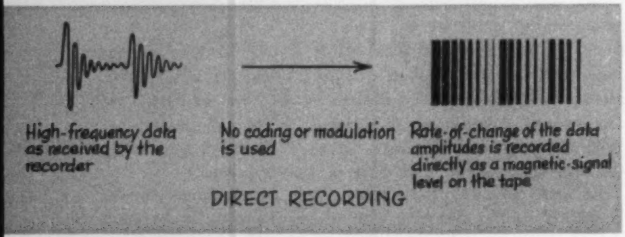
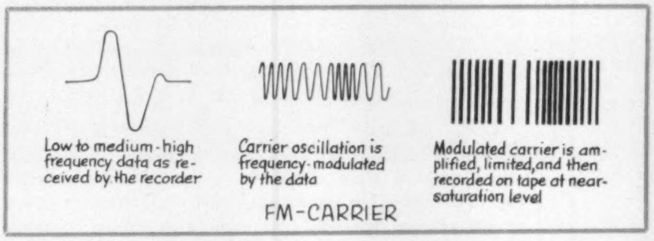
rate is the rate at which information can be placed on, or retrieved from, the tape. It is a function of bit packing density and tape speed. For example, 200 characters per inch at a tape speed of 60 inches per second will produce a transfer rate of 12,000 characters per second.

Types of Recording Systems

Four types of magnetic recording systems are used throughout industry. These types are: 1. Direct recording. 2. FM-Carrier. 3. Pulse-duration modulation (PDM). 4. Pulse-code modulation (PCM).

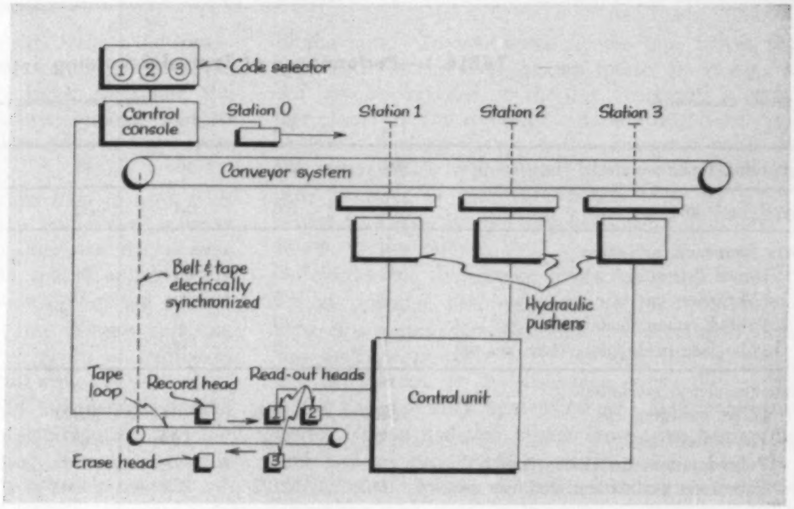

High-frequency data as received by the recorder
No coding or modulation is used
Rate-of-change of the data amplitudes is recorded directly as a magnetic-signal level on the tape
DIRECT RECORDING

Direct recording. Although this type is one of the simplest systems and has the highest recording frequency for a given tape speed, it has a disadvantage of being unable to deliver a steady-state signal output. This is mainly due to the fact that most magnetic reproducing heads are sensitive to the rate of change of flux on a tape. In this type of system, the signal amplitude can vary widely due to variations in tape, head-to-tape contact, and dropouts. Low-frequency signals are difficult to amplify and are subject to drift. With such variations in accuracy, the choice of a direct recording system should be made only after careful study of the proposed end use. Direct recording will probably be satisfactory if data is desired in terms of frequency only. However, when amplitude data is to be recorded, the output signal can be in error as much as plus or minus 20 per cent. In many cases this may be unimportant since the statistical distribution of amplitude variations for a large number of data points may be relatively good.


Low to medium-high frequency data as received by the recorder
Carrier oscillation is frequency-modulated by the data
Modulated carrier is amplified, limited, and then recorded on tape at near-saturation level
FM-CARRIER

FM-carrier. When an FM-carrier system is used, it has an advantage of being rather insensitive to amplitude varia-

Fig. 6—Magnetic tape loop incorporated in this conveyor sorting system is used to record the discharge point of packages placed on the conveyor. The tape loop moves a proportionate distance as the main conveyor, and readout heads for the various discharge stations activate hydraulic pushers when a particular package reaches its proper discharge station.

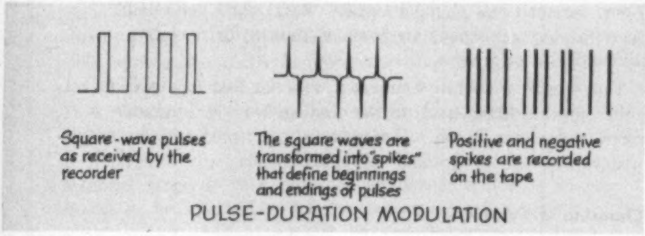


① ② ③
Code selector
Control console
Station 0
Station 1
Station 2
Station 3
Conveyor system
Belt & tape electrically synchronized
Hydraulic pushers
Tape loop
Record head
Read-out heads
1
2
3
Control unit
Erase head

rial being processed is detected by some means, and suitable modifying instructions are given to the machine in order that corrections of some kind can be made in the work. The measurement is made some distance from the point at which the work can actually be done. For this reason, magnetic tape has proved to be valuable in storing such measurement information for a short period of time until corrective action can be taken. Such a procedure has been used for a hide-spraying system using a magnetic tape loop as a storage element, *Fig.* 5.

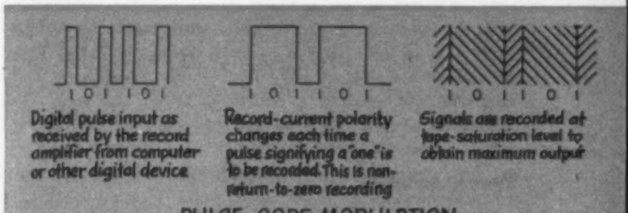
Metallic fingers, extending through a conveyor consisting of a series of parallel belts, are depressed as the hide moves along the conveyor. The fingers actuate switches which apply a control signal to a magnetic tape loop by means of a rotary scanner that samples each of the switches several times a second. Tone bursts are recorded on a magnetic tape to correspond to areas of the conveyor which are

tions on tape playback, but spurious frequency components may be introduced by flutter variations. In most cases these variations are usually less than 1 per cent for wideband deviation systems. More than one FM-carrier may be multiplexed on a single track. However, FM-carrier techniques result in a considerable reduction in useful data frequency range. For example, the maximum data frequency is about 1/5 the center carrier frequency. Although it is possible to use amplitude modulation, this technique is sensitive to amplitude variations of the recording medium, similar to direct recording, and is not widely used.



Square-wave pulses as received by the recorder
The square waves are transformed into "spikes" that define beginnings and endings of pulses
Positive and negative spikes are recorded on the tape
PULSE-DURATION MODULATION

Pulse-duration modulation. This technique can be used in cases where relatively high accuracy is required in recording slowly changing parameters. To use this technique, it is necessary to sample a signal at periodic intervals to determine its amplitude and to convert the amplitude into a square wave with a variable time duration by electronic means. Fairly complex electronic coding and decoding circuits are required, and usually the upper frequency limit is considerably reduced in comparison to other systems. However, an over-all system accuracy of 1 per cent is possible. When a large number of measurements are to be sampled in sequence and multiplexed on the same track of tape, the pulse-duration modulation technique is advantageous.



1 0 1 1 0 1
Digital pulse input as received by the record amplifier from computer or other digital device
1 0 1 1 0 1
Record-current polarity changes each time a pulse signifying a "one" is to be recorded. This is non-return-to-zero recording
1 0 1 1 0 1
Signals are recorded at tape-saturation level to obtain maximum output
PULSE-CODE MODULATION

Pulse-code modulation. This technique is another name for digital recording. Data is first digitized or converted to a binary or binary-coded number. The data is then recorded serially on one or more parallel tracks on a tape. The digitizing process also requires that data be sampled at periodic rates and converted into a discrete digital number, resulting in a discontinuous record. Accuracy of the system is not limited by the magnetic tape, but is limited

TABLE 1—Performance of Typical Recording Systems

System Characteristic	Tape Speed, inches per second							
	1⅞	3¾	7½	15	30	60	75[6]	150[6]
Recording time, minutes[1]	294	192	96	48	24	12	8	4
Speed variation, per cent[2]	0.75	0.6	0.4	0.25	0.25	0.2	1.0	1.0
Data frequency, minimum								
Direct Recording, cps	40	40	40	40	40	40	..	..
FM-carrier, cps	0	0	0	0	0	0	..	..
Pulse-duration modulation, cps[3]	0	0	0	0	0	0	..	..
Pulse-code modulation, char. per sec.	0	0	0	0	0	0	..	..
Data frequency, maximum								
Direct recording, cps	3500	7500	15,000	30,000	50,000	100,000	..	..
FM-carrier, cps	325	625	1250	2500	5000	10,000	..	..
Pulse-duration modulation, cps[3]	..	..	180	180	180	180	..	..
Pulse-code modulation, char. per sec.	662	1125	2250	4500	9000	18,000	22,500	45,000
Approx. system accuracy, % full scale								
Direct recording	±20	±20	±20	±20	±20	±20	..	..
FM-carrier	±5–6	±5–6	±3–5	±3–5	±3–5	±3–5	..	..
Pulse-duration modulation	..	..	±1–2	±1–2	±1–2	±1–2	..	..
Pulse-code modulation	±0.25	±0.25	±0.25	±0.25	±0.25	±0.25	±0.25	±0.25
Maximum interchannel timing error, microseconds	640	320	160	80	40	20	26	14
Approx. recorder cost, per data channel								
Direct Recording[5]	$1200	$1200	$1200	$1200	$1200	$1200	..	..
FM-carrier	$1400	$1400	$1400	$1400	$1400	$1400	..	..
Pulse-duration modulation[3,5]	$1200	$1200	$1200	$1200	$1200	$1200	..	..
Pulse-code modulation[4]	$14,000	$14,000	$14,000	$14,000	$14,000	$14,000	$14,000	$19,000

1. For 10½ inch reels of 1-mil Mylar tape, 3600 feet per reel. For other reel sizes and tape thicknesses, adjust accordingly.
2. Commonly called "flutter" and expressed in peak-to-peak speed changes as a per cent of normal.
3. PDM figures based on 900 samples per second of one variable. If multiplexed signals are used, divide figures for high limit by number of data sources.
4. PCM figures based on 14-track system with one 14-bit data channel using all tracks across the tape and a character density of 300 bits per inch.
5. Based on 14 analog or digital tracks per recording machine. For fewer tracks, cost per channel will be higher.
6. Tape speeds of 75 and 150 inches per second apply to digital machines only.

only in terms of the accuracy of the original measurement and the method by which the measurement is digitized. Resolution in the system is in terms of the number of binary bits which are used in each number. For example, an 11-bit character will produce a resolution of 0.1 per cent. Few analog transducers can approach this degree of accuracy.

System Accuracy

Many factors influence the system accuracy that can be obtained from a tape-recording system. Primary transducers or measuring devices always have a finite error in terms of linearity, drift, or resolution. These same errors can also be found in the magnetic tape equipment and in the devices which are operated by the signals on a tape. Tape system errors may be due to any of the following equipment characteristics:

Poor Linearity. Output signal deviates from a true representation of the input signal.

Drift. Absolute level or slope of the input-output characteristic is changed.

Poor Resolution. Equipment is unable to distinguish between various levels of input signals. Background noise and spurious electrical signals are common sources for resolution difficulties in equipment.

Tape-speed variations. Equipment does not feed tape past either the recording head or the reading head at constant speed and causes flutter. Variation in tape speed can introduce frequency errors and unwanted signals.

Choosing a System

Precise performance levels of a given tape system are difficult to predict until all operating factors are known and checked out. However, general ranges of performance can be indicated for various types of systems as shown in Table 1. Choice of an optimum system, as in many other fields of engineering, results from a compromise of many covered by leather. These signals control the spraying operations to assure that expensive chemicals will be used only when the hides are under the spray gun. Uses of this machine indicate that its cost has been paid off in less than a year from savings in chemicals alone.

In this system, a simple tape loop is used with a pair of recording heads, one for the forward traverse of the spray gun and the other for the reverse motion. Two playback heads, spaced appropriately along the length of the tape, pick up the control signals at the correct time and initiate spraying action. Another head, driven by an ac oscillator, erases the recorded signals following the last playback and before a new signal is recorded on the tape. Users of this machine have reported tape life from two weeks to six months. The limitation is usually on how well the loop splice is made.

Conveyor Systems. In warehouses, cartons arriving at one point of the building must be distributed throughout the storage area in a systematic manner. With an automatic conveyor system, routing must be determined and recorded so that controls can respond to the recorded information. A typical system incorporates a magnetic tape "scale model" of the actual conveyor layout, *Fig.* 6. A loop of magnetic tape represents an endless belt-type conveyor with conveyor and tape synchronized.

Distance on the conveyor from the timing point to the farthest exit station determines the length of the tape. To save space on the tape panel, the tape may be run over zig-zag rollers as in *Fig.* 4. An impulse recorded on the tape represents a package placed on the conveyor. A recording head represents a loading station, and a discharge point on the conveyor is represented by a playback head. Any number of discharge points may be represented by a separate playback head at the appropriate point on the tape.

Selection of the proper discharge point is made by an operator pushing a selector button. However, this is not always enough information to eject the package properly. To be sure that a package is centered at the discharge point, the center of the package must be determined. A photoelectric device is also included which senses the beginning and end of each package as it passes along the conveyor and locates the control signal on the tape in such a way that the package will be moved by the pusher at the proper time.

Large warehouse conveyor systems, suitably controlled by magnetic tape, have shown operating savings up to $100,000 per year. Such savings are in addition to advantages of avoiding human errors in misplacing of stored material.

Automatic Testing. Repetitive operations, such as automatic testing of electronic assemblies, has proved a fruitful field for automation. Complex testing procedures recorded on tape reduce the danger of operator fatigue and error. Automatic test equipment will permit increased accuracy, speed, and reliability. Though such a system may be complex internally, simple operator controls minimize skill required. Verbal instructions for the operator may also be included on the tape.

Related to automatic testing is the very large field of automatic assembly machines. Electrical and mechanical devices are now being assembled by automatic machinery.

▶ Future Automatic Control

There will be an increasing use of automatic machine tools, controls, and processes for it has already been demonstrated that such systems are practical technically and economically. Often automatic control is the only answer to a difficult manufacturing problem.

Magnetic tape is a useful medium for information storage in automatic control systems. Its use has the greatest advantage when properties unique to magnetic tape can be employed. These are a permanent, but erasable, memory; high degree of accuracy; large storage capacity; availability of stored information in "live" form; indefinitely repeatable recordings; and close interchannel time correlation of a large number of data channels. Only in magnetic tape can all these features be found. Magnetic tape is no longer a beginner in the field of machine tool or process control, but has a demonstrated history of dependable and economical performance as a memory device for such systems.

opposing factors. For example, a need for long playing time may be obtained by limiting the highest frequency of data which may be recorded. Also, higher accuracy of recorded information may be obtained by sacrificing bandwidth. Long-playing time and greater accuracy may also be obtained by designing more sophisticated systems. However, it is necessary for a system designer to carefully analyze his requirements and to be sure that he is not asking for more in performance than he actually needs.

Recording time is inversely proportional to tape speed. For a given reel of tape, an increased tape speed (to achieve the capacity for recording higher data frequencies) will result in a shorter recording time. Speed variations (flutter) are usually lower at the higher tape speeds. This is understandable because capstan speeds are steadier due to higher angular momentum, and the tape has less tendency to vibrate as it passes over the heads. Systems requiring extremely low flutter should take this factor into account.

The system characteristics listed in TABLE 1 are based on standard magnetic tape recording equipment which is believed to be appropriate for the industrial and automatic control fields. They do not include higher capabilities which are now available in specialized equipment for the military instrumentation fields. For example, a maximum limit of 100,000 cps response at 60 ips has now been raised to 250-500 kilocycles. Also, wideband recording up to 3 or 4 megacycles is available with instrumentation versions of television-type recorders that use a rotating head.

MULTIPLE HEAD MACHINE INDEXES PARTS VERTICALLY

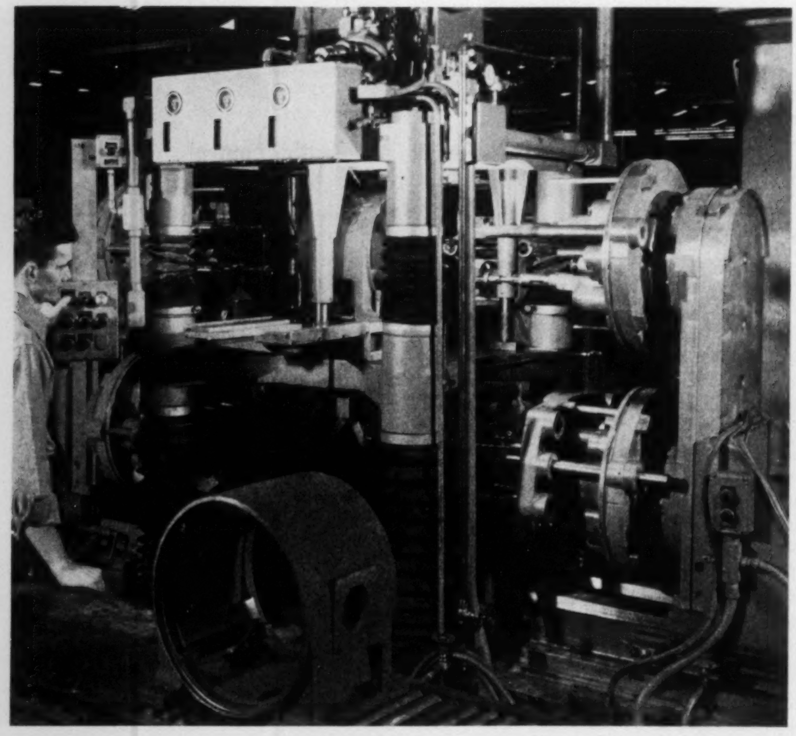
TIME savings of 75 per cent have been achieved by Elliott Co., Div., Carrier Corp., in the production of motor frame brackets through the use of a 4-way drilling and tapping machine developed by Morris Machine Tool Co. Production rate is 33 frames per hour, and ten different motor bracket sizes, 180 to 320 NEMA, are handled by the machine.

The vertical indexing machine is composed of three 12-inch way-type hydraulic drill units, each equipped with 2-spindle master heads, and an overhead pneumatic drill unit equipped with a 2-station turret. On the left and right-hand slide units an 8-spindle double eccentric adjustable head is mounted on each master head. The rear slide unit is similar except that 5-spindle double eccentric adjustable heads are mounted on the master heads. The overhead unit, air operated on a 6-inch sliding adjustable base with vertical adapter, includes a 2-station turret drillhead for drilling and tapping an eyebolt hole in each frame.

In operation, a motor frame bracket is slid off a conveyor and manually loaded onto a fixture adapter plate which compensates for different centerline heights of the various frame sizes. After being clamped into place, the part is drilled by the lower spindle heads of the three sliding master heads. The lefthand head drills a maximum of 8 holes in the bracket mounting bolt circle on one side of the frame, the righthand head drills up to 8 holes in the bolt circle on the other side of the frame, and the rear unit drills a maximum of 4 holes in the conduit bolt circle and drills one drain hole when required in a part.

The part and fixture are then hydraulically indexed in a vertical direction to the second machining position. The three master heads again advance and tap the holes drilled by the lower spindles. These include 8 holes on each side of the frame in the bracket mounting bolt circles, 4 holes in the rear in the conduit bolt circle, and the drain hole if required. In addition, the overhead pneumatic turret drills and taps an eyebolt hole in the frame.

For different frame sizes, changes in tooling are accomplished by switching tool fixtures within the 20-inch cubic mounting area. Slip spindle heads are used to facilitate altering of the various spindle centers as required. Up to 21 drilling and tapping operations can be made in one automatic cycle without readjustment of the drill units. Tolerance of plus or minus 0.003 inch is maintained on the bolt circles of the cast iron brackets.

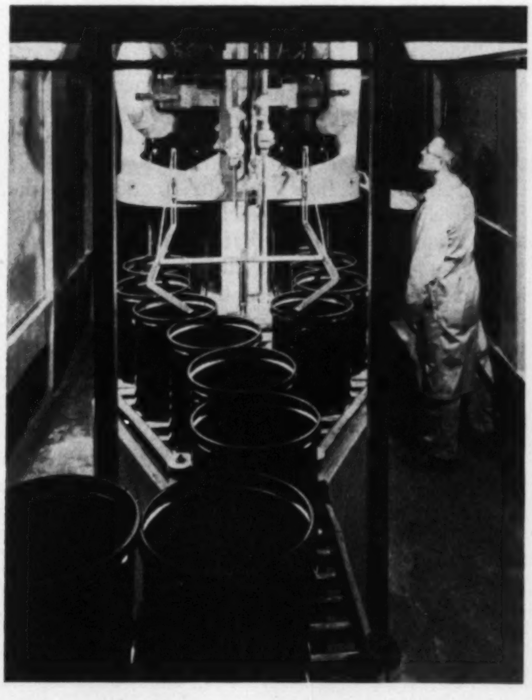


Motor frame brackets such as the one in the foreground are drilled and tapped with up to 11 holes in this 2-position drilling and tapping machine that indexes parts vertically to the second position. In lower position a bracket is drilled by sliding heads advancing from the left, from the right, and from the rear. In the upper position, shown, the drilled holes are tapped by the three horizontally sliding heads, and an eyebolt hole is drilled and tapped in the top of the casting by a pneumatically operated 2-station turret head sliding in a vertical direction.

CENTRIFUGAL METHOD LINES PAIL BODIES

INCREASING variety of chemicals, paints, petroleum products and their derivatives, sanitary and maintenance products, and foods packed in pails has imposed on pail manufacturers the necessity of developing improved methods of lining the insides of their containers with special coatings. The function of these coatings is to physically isolate the products from the steel containers and thus prevent either chemical attack on the containers by the products or contamination of the products through contact with the metal. It follows, of course, that the lining materials should be inert with respect to both the products and the container, and adhere readily to the metal.

Laboratory testing methods and special equipment developed by the Container Div., Rheem Mfg. Co., are designed to provide users with pails that have a variety of economically applied linings. Typical lining materials that can be applied include thermosetting and thermoplastic synthetic resins such as phenolics and vinyls.



One of the first steps in developing a lining for a pail is to establish the basic chemistry of a customer's product. Two laboratory routines are available for this purpose. In one, the product to be shipped is exposed for predetermined lengths of time to both lined and unlined steel surfaces and reactions are observed. The other procedure is employed when preliminary lining specifications have been developed in working with the customer. This involves lining a test cup with the selected material and subjecting the cup and product to simulated packaging conditions. An accelerated test room is available where the samples can be stored under controlled conditions of elevated temperature.

Testing for characteristics of lining materials is done both in the development and production phases of manufacturing lined steel shipping containers. Through instrumentation in the container laboratory, quality control tests are conducted regularly to check the suitability of various lining materials. Tests performed on the materials help develop data on the impact strength of cured linings, product resistance, optimum film thickness, and uniformity of applied linings.

Once the correct formulation of a container lining material has been determined, the material is applied to pails on a production basis. Requirements of the process include application of linings in the form of continuous, unbroken films throughout the interiors of the containers, particularly over potential trouble spots such as bottom double seam areas and in swedges. In addition, application techniques must not introduce contaminants such as oil, grease, and dirt from the atmosphere.

An interesting phase of the application process is the lining of cylindrical pail bodies before tops and bottoms are assembled. Specialized equipment, developed originally for applying linings to drum bodies, has been adapted for pail bodies, *Fig.* 1.

In operation, pail bodies moving in single file on an input conveyor are diverted into separate lines leading to twin, centrifugal lining stations. As a

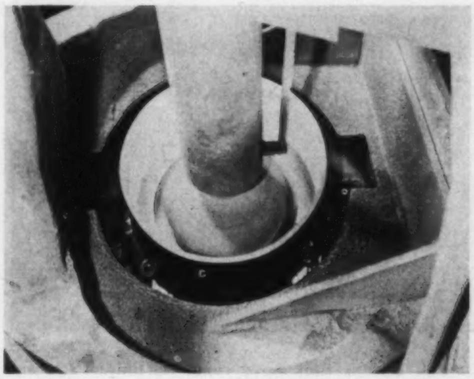


Fig. 1—Five-gallon pail bodies are automatically loaded in dual stations of a centrifugal lining machine that applies coatings to inside surfaces. Inset shows spinning rotor that dispenses lining material as pail body is raised and lowered without rotating.

pail body enters a station, the body is automatically elevated and lowered for application of lining material to its inner surface by a spinning rotor. The lining material is impelled centrifugally to the wall of the container through thousands of small apertures on the rim of the rotor which spins at more than 7000 rpm. Application is continuous during both the upward and downward passes so as to provide complete coverage of all internal areas with a uniform coating.

Advantages of the centrifugal lining process include: 1. It is possible to use less solvent in the lining material formulation than with spray processes. This reduces the possibility that pinholes and blisters will develop due to evaporation of solvent during the curing process. 2. Air pressure is not needed as a propellent for the lining material, and the container body is not rotated. Thus, excessive turbulence is not created by high velocity air flows to cause dirt pickup and air bubbles on the container surface. Also, air barriers are not created that prevent the lining particles from reaching critical container areas.

After they have been coated internally, the container bodies are discharged from the centrifugal machine and passed through an oven, *Fig.* 2, where the linings are cured. Flexibility is an important requirement of the oven because of the wide range of lining materials that must be processed. For example, some linings consist of resins that must be fused, while other linings require polymerization to produce a desired molecular structure. To bring about these conditions, controls regulate the oven heat and speed of movement of pail bodies through the equipment.

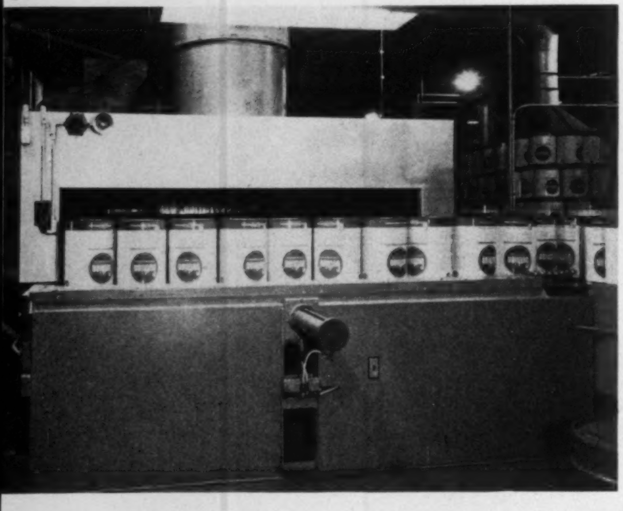


Fig. 2—Pail bodies that have received linings are fed automatically to this curing oven. When a line of bodies has formed on a conveyor at the input end of the oven, a limit switch is tripped, and a hydraulic ram pushes the oven-wide line of pail bodies into the unit. Heated air at a controlled temperature circulates by flue action through the cylindrical bodies. Processing speed is adjustable for optimum curing time.

CONVEYOR SCALES CONTROL BAUXITE REFINING PROCESS

ALUMINA, a white powder from which basic aluminum metal is made, is extracted from South American bauxite at a modern refinery of Ormet Corp. at Burnside, La. The extraction process consists of the following operations: 1. Unloading of raw ore from ships. 2. Crushing, storing, and rod milling the bauxite ore. 3. Digestion in which the ore is made into a slurry. 4. Filtration where waste is filtered out. 5. Precipitation where alumina is separated from process liquors. 6. Calcination in rotary kilns where water is driven off from the aluminum oxide crystals. 7. Loading the finished powder into barges for shipment to a reduction plant at Hannibal, Ohio.

Solid materials at various stages of processing are continuously weighed and in some cases controlled by electronic belt conveyor scales designed and built by Trans-Weigh Co. Each of the electronic weighing units measures material weight and speed by means of a Belt-Meter system. The system measures the weight of material on a short section of belt by means of a weighing carriage equipped with a resistance-type load cell, and at the same time a tachometer generator determines the speed of the conveyor belt. The output of the generator is fed to the load cell, and the combination generator-load cell signal is transmitted electrically to a modified electronic potentiometer that indicates and records the instantaneous flow of material. Some of the Belt-Meter recorders are used for inventory purposes and include an integrator that displays the totalized tonnage of material on a digital counter. Other instruments are used for control and are equipped with pneumatic control units, including those elements necessary for wide-band proportional control and automatic reset; pneumatic transmitters; and adjustable control index devices.

In all, seven scale units are used in the processing system, and each scale varies as to function and operation. Scale 1 is located on a conveyor between the crusher building and the storage building and measures the total incoming weight of raw ore. Scales 2 and 3 weigh the crushed bauxite as it is fed to the rod mills. The recorder for each scale is equipped with a pneumatic control unit having

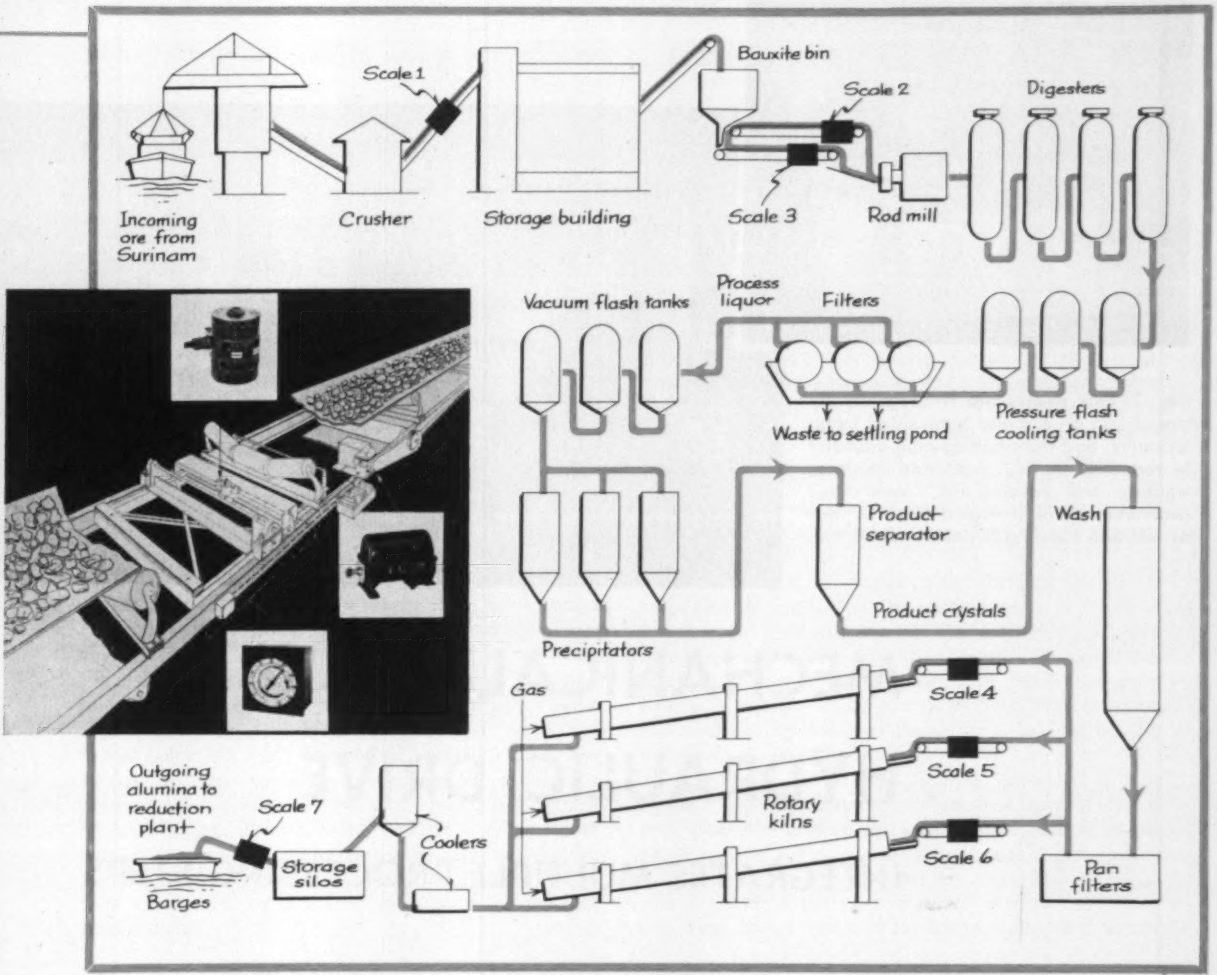

Incoming ore from Surinam
Scale 1
Crusher
Storage building
Bauxite bin
Scale 2
Scale 3
Rod mill
Digesters
Vacuum flash tanks
Process liquor
Filters
Pressure flash cooling tanks
Waste to settling pond
Product separator
Wash
Product crystals
Precipitators
Gas
Scale 4
Scale 5
Rotary kilns
Scale 6
Pan filters
Outgoing alumina to reduction plant
Scale 7
Storage silos
Coolers
Barges

Diagram illustrates the flow of materials through the ore refining process. Seven electronic belt conveyor scales, similar to unit shown in the inset, are used to control material flow at various stages of the process. In each belt conveyor scale, a load cell measures the weight of material on a short span of belt at the same time that a tachometer generator measures the speed of the belt. A combination signal is fed to a recorder which either indicates and records the instantaneous flow of material or controls the feed of material into process equipment.

a 3-15 psi control signal that regulates the addition of bauxite through a variable speed drive on the belt feeder.

During the calcination process, three rotary kilns are employed to drive off water from the aluminum oxide crystals. Each kiln is equipped with a Belt-Meter scale and a cascade-type control system that maintains a constant kiln temperature. The cascade control technique utilizes the output or controlled air signal from a temperature control instrument to feed the index or set point of each controller for Scales 4, 5, and 6. Constant kiln temperature is obtained through regulation of the hydrate filter cake (incoming feed) delivery to the kiln by setting the control point of the scale with a pneumatic signal from the kiln temperature recorder. Control action for the kilns is effected through regulation of variable speed drives on the filter cake feeders.

The last scale is used to record and totalize the total plant output of alumina. This scale, No. 7, is located on a conveyor between the output storage silos and the barge loading dock. The ore processing facility has a capacity of 345,000 tons of alumina per year. In addition to metering and regulating material flow at selected points in the processing system, the belt conveyor scale units provide accurate input and output data for management and cost accounting purposes.

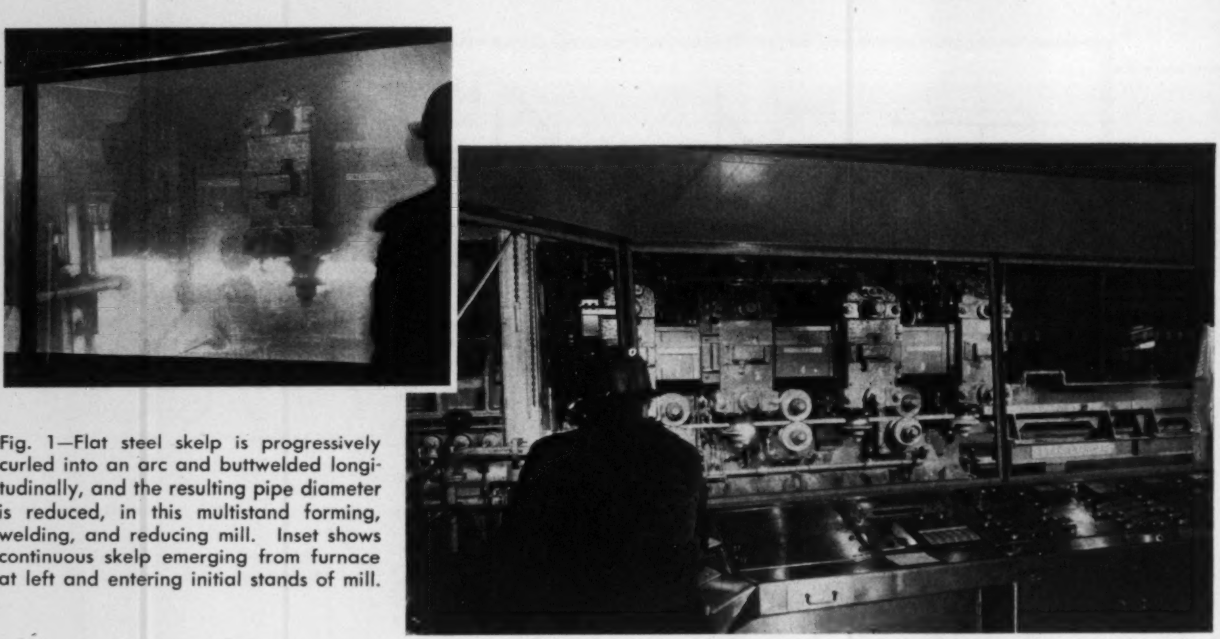


Fig. 1—Flat steel skelp is progressively curled into an arc and buttwelded longitudinally, and the resulting pipe diameter is reduced, in this multistand forming, welding, and reducing mill. Inset shows continuous skelp emerging from furnace at left and entering initial stands of mill.

MECHANICAL-HYDRAULIC DRIVE

INTEGRATES MULTIPLE PROCESSING STEPS

Vital to the success of many continuous web and filament processes is the maintenance of critical speed relationships among successive workstands. Where a variety of product types or sizes is made, a range of system operating speeds may also be required. Principles employed in a mechanical-hydraulic drive system that meets these requirements for a continuous buttweld pipe mill are applicable elsewhere.

By C. W. MODERSOHN, Chief Engineer, Special Products Div., Beloit Iron Works, Beloit, Wis.

MULTISTAGE SYSTEMS that process continuous web or filamentary materials usually require drives that can provide flexible and accurate speed control of each stage. Typical systems where drive speed control is important include those for producing wire, paper, pipe, rod, and bar. In each case, drive speed control is necessary to hold product tolerances and ensure economical operations.

Characteristically, materials being processed are placed under tension between stands. Such stressing may be required to accomplish permanent deformation of the material or it may be imposed simply to avoid slack. In either case, upper and lower allowable limits of tension exist and are sometimes quite close together. In wire drawing, for example, the tension range must be small to ensure maximum reduction per block. This maximum reduction occurs when the material is stressed close to, but not in excess of, its yield strength.

In paper making, the difference between nominal operating tension and that allowing a slack condition is very small. The problem is further complicated by the requirement for tension control at significant power levels, high speeds, and with very large inertias connected to the drives. In the case of pipe manufacture, rolling to form the shape is combined with stretch between stands to control wall thickness. Here, wall thickness tolerances can be no better than the accuracies of stand-to-stand speed ratios. In rod mills, particularly in the finishing stands, close control of speed ratios is necessary for maintaining product size tolerances.

These requirements for speed control suggest the use of a lineshaft drive with the individual stands geared in at appropriate fixed speed ratios. In all of the examples, however, a range of speed above and below a base speed must be available at each stand in order to adapt the machine to a variety of products. Ideally, this speed range should be provided in such a way as to retain the "hard" drive characteristic of direct gearing to a common lineshaft.

One very satisfactory means of attaining this dual objective has been a mechanical-hydraulic drive which includes a common lineshaft, a system of drive gears for each processing stand, and a hydraulic section working through a differential to provide the variable fraction of speed and torque for each stand. Such a drive, used in a critical portion of a new, continuous buttweld pipe mill at the Lorain Works of National Tube Div., United States Steel Corp., will be described in light of the product requirements.

▶ Buttweld Pipe Process

Pipe making at the new facility begins when a coil of skelp material is threaded through the pinch rolls of an uncoiling leveler. To maintain tension between the coil and leveler, a mandrel supporting the coil is driven by a drag generator. Hydraulically operated side guides position the coil on the centerline of the pass.

To provide an endless web of skelp to the mill, a shear and flash welder are placed between the uncoiling leveler and a following pair of pinch rolls. The shear provides a square cut in the skelp ends and the welding equipment joins the trailing end of each coil to the leading end of the succeeding coil. Upon completion of a weld, the joint is automatically advanced to a trimming station where the flash is removed. Joints prepared in this manner have a smooth surface and weld characteristics which are equivalent in strength to that of the parent skelp metal.

After welding, the skelp passes through the pinch rolls and is guided to the floor where it forms a large loop. The purpose of this loop is to provide sufficient material to ensure continuous operation of the mill during the welding cycle. Several magnet roll units are provided on the looping floor to assist the uncoiler leveler and pinch rolls in feeding the skelp into the storage loop.

Material in the storage loop is advanced into a furnace preheat chamber by another pair of pinch rolls near the end of the loop. The speed of these pinch rolls is regulated according to mill demand.

Skelp heating is conducted on a continuous basis. The skelp first enters a two-pass preheat chamber and then passes into a main furnace chamber where

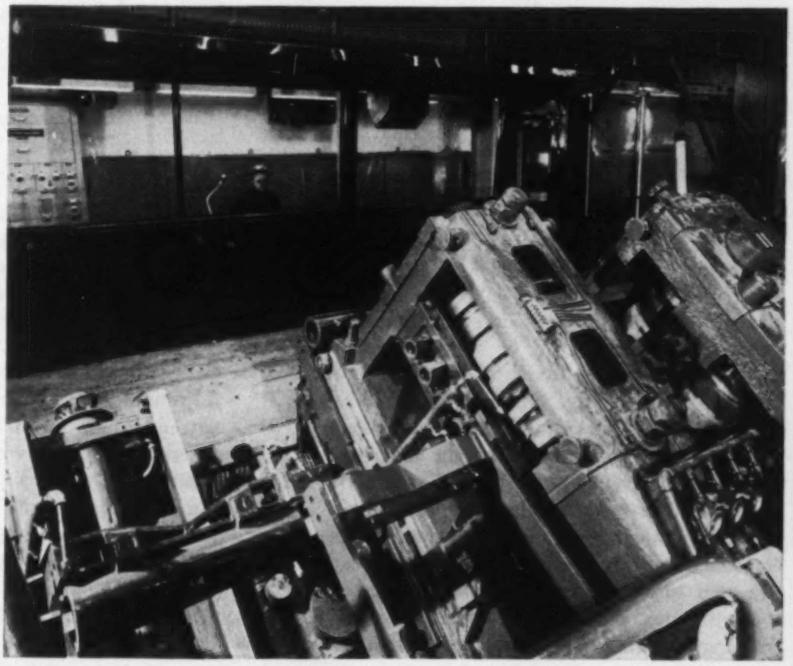


Fig. 2—Stretch reducing mill further decreases diameter of continuous pipe leaving forming, welding, and reducing mill. Axes of adjacent stretch reducing rolls are displaced 90 degrees from each other. Stands can be positioned hydraulically on sleds so that any of five grooves in each roll can be used. Arrangement permits six pipe sizes to be produced without changing rolls.

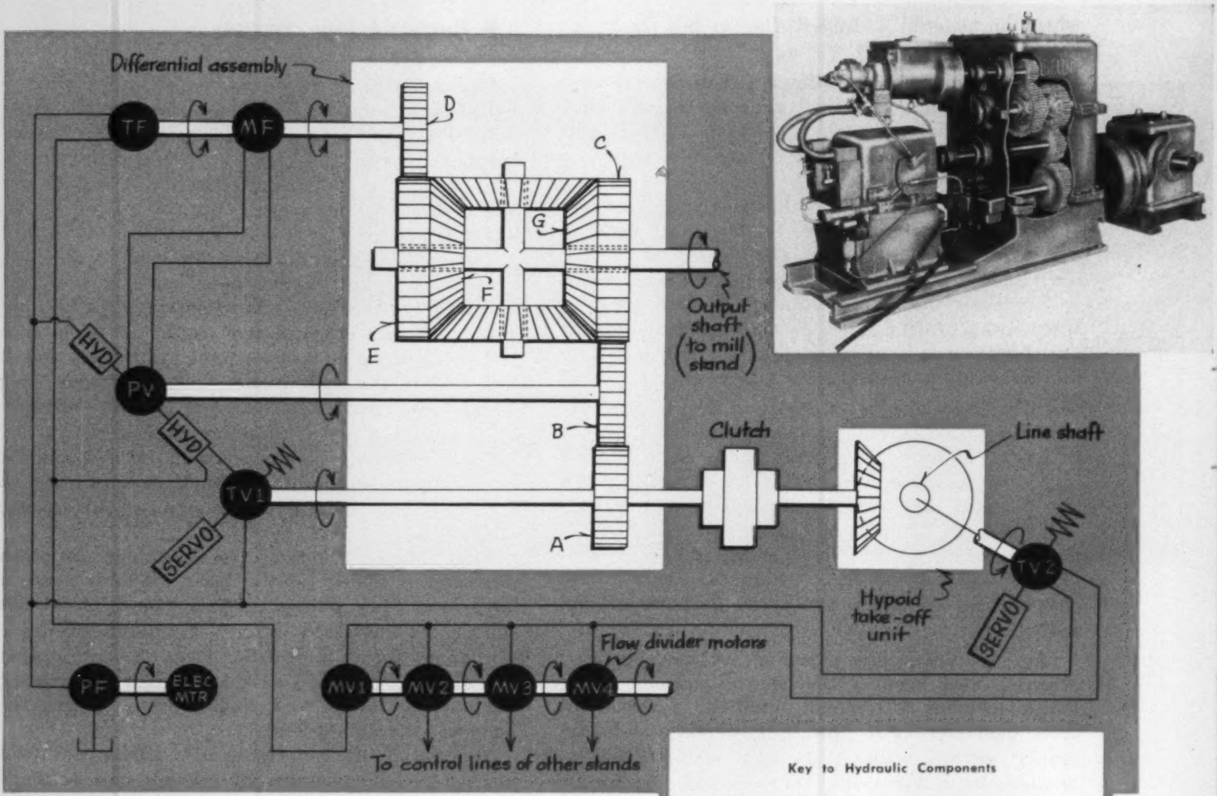


Fig. 3—Simplified diagram illustrates major elements of mechanical-hydraulic drive for one mill stand. Function of drive is to permit individual adjustment of speed of each stand in preset relation to speeds of other stands for optimum processing conditions. Drives of this type, powered from a common line shaft, are provided for stands in the forming, welding, and reducing mill and the stretch reducing mill. Inset shows arrangement of mechanical and hydraulic components.

Key to Hydraulic Components

MF — Motor, fixed displacement
MV1, MV2, etc. — Motor, variable displacement
PF — Pump, fixed displacement
PV — Pump, variable displacement
TF — Tachometer, fixed displacement, slave
TV1 — Tachometer, variable displacement, stand master
TV2 — Tachometer, variable displacement, main mill

it is heated to welding temperature. The preheat chamber utilizes waste gases from the main furnace chamber. Capacity of the furnace when using the preheat chamber is 70 tons per hour of 0.225 by 17½ inch skelp.

Located directly after the discharge door of the furnace is a seven stand forming, welding, and reducing mill, *Fig.* 1. The rolls of this unit are single pass, and are set alternately 90 degrees to each other so that the roll axes of odd-numbered stands are vertical and the axes of even-numbered stands are horizontal.

Hot skelp leaving the furnace enters Stand 1 of the forming, welding, and reducing mill where it is curled laterally into an arc of approximately 270 degrees. After this operation, the skelp is guided by a welding horn into Stand 2 where the skelp edges are pressed firmly together and welded. Simultaneously, the diameter of the resulting tube is reduced. The remaining five stands of the mill are used to obtain diameter and wall reduction.

Continuous pipe leaving the last stand of the forming, welding, and reducing mill next moves through a multiple pass stretch reducing mill, *Fig.* 2, for diameter reduction. This mill consists of seven, 2-high roll stands. The roll shafts are mounted at an angle of 45 degrees to the horizontal, with the roll axes of adjacent stands displaced 90 degrees to each other.

Each stand of the stretch reducing mill is mounted on a sled which is movable by a hydraulic cylinder. Adjustable stops, which can be changed by a handwheel on the front of each mill stand, position the sleds so that any one of the five grooves in each roll can be selected. By this means, six pipe sizes can be made without changing rolls. The forming, welding, and reducing mill and the stretch reducing mill were supplied by Aetna-Standard Div., Blaw-Knox Co.

After it is stretch formed to desired size, the continuous pipe is cut into predetermined, discrete lengths by a rotary type flying hot saw. The cut lengths then pass through a three stand sizing mill which reduces the OD to the required hot size. From the sizing mill, the pieces enter a kickout where they are decelerated and ejected to a cooling bed. As they move across the cooling bed, the ends of the pipes are cropped by sawing. Double-length pipes may be cut into two pieces by a saw overhanging the kickout.

Pipes that have traversed the cooling bed enter a water bosh tank from which they are conveyed directly to a pair of rotary straighteners. Subsequent operations include inspection, end facing, finishing, and storage.

▶ Drive Specifications

Requirements of the drive system for the seven-stand forming, welding, and reducing mill and the seven-stand stretch reducing mill were dictated by product considerations. For example, the system produces pipe in seven sizes: 1¼, 1½, and 2-inch pipes are produced from 13½-inch wide skelp; and 2½, 3, 3½, and 4-inch pipes are made from 17½-inch wide skelp. The mill delivery speeds vary from 625 fpm for 1¼-inch pipe to 150 fpm for 4-inch pipe. As a first consideration, therefore, the drive must provide for seven mill processing speeds.

Changing pipe production from one size to any other size is done with a single switch on a master control console. This switch selects one of two preset potentiometer controls on each stand. While the mill is in production, the inactive potentiometer on each stand can be preset to the speed setting for the next size pipe to be produced. Thus, with the single switch, all stands change speeds to produce the new size of pipe.

To obtain maximum stretch reduction during manufacture of a particular pipe, each stand must be driven in a preset speed relation to the other stands. Precise speed regulation and maintenance of roll speeds without drift from initial settings, are also required.

If, due to a variation in skelp thickness, finished pipe is delivered from the stretch mill off gage (too heavy or too light), the over-all elongation should be automatically distributed simultaneously and uniformly to the stretch reducing mill stands to bring the pipe wall thickness back to its standard gage. This can be accomplished with drive control potentiometers that permit roll speed adjustments of up to ±1 per cent of normal processing speeds for each individual stand in a mill. Thus, up to 1 per cent mill overspeed is available for decreasing the wall thickness of pipe made from oversize material, and up to 1 per cent underspeed can be chosen to increase the wall thickness where undersize material is being processed.

Overspeed or underspeed is based on No. 8 or No. 9 stand, and is adjustable up to ±1 per cent per stand in a geometric progression. Thus, up to ±7 per cent speed adjustment can be provided at stand No. 14.

▶ Mechanical-Hydraulic Drive System

The drive system selected, *Fig.* 3, includes a single, 1000-horsepower dc motor powered by a motor-generator set. The base speed of the dc motor is 500 rpm. Lower speeds are obtainable by motor voltage control, and speeds from 500 to 1000 rpm are achieved by field control of the motor. All 14 stands of the two mills are driven by this motor through a common lineshaft. Coupling to each stand is through a hypoid take-off unit, a clutch, and a differential assembly.

The purpose of each differential assembly, supplied by Beloit Iron Works, is to provide a means of varying and/or adjusting the speed of each mill stand individually without changing the speed of the main mill lineshaft. This is accomplished by rotating the differential gearing independently of the speed of the main drive unit. Rotation of the differential gearing in one direction produces a corresponding additive effect to the output speed, while rotation of this same gearing in the opposite direction produces a corresponding subtractive effect to the output speed. Hydraulic components and controls supplied by The Oilgear Co. provide the desired rotation of the differential gearing.

Operation of the drive system for one mill stand may be followed by reference to *Fig.* 3. Assume that lineshaft speed is 1000 rpm. Gears *A*, *B*, and *C* are so proportioned that gearshaft *B* (driving variable displacement hydraulic pump *PV*) will then rotate at 1265 rpm and gear *C* (which is integral with bevel gear *G*) will rotate at 1000 rpm.

Since bevel gears *F* and *G* have equal pitch diameters, the differential assembly becomes a 2 to 1 speed divider. That is, the output shaft—which is integral with the differential cluster—will rotate at one-half the algebraic sum of the inputs to gears *F* and *G*. With gear *F* held stationary, for example, the output shaft speed will be 500 rpm for an input speed of 1000 rpm to gear *G*.

With hydraulic pump *PV* rotating at 1265 rpm, a hydraulic motor, *MF*, driving gear *D* may be rotated at a maximum speed of 1180 rpm in either direction, allowing for some losses. Because of gear reduction between gears *D* and *E*, gear *E* (and thus gear *F*) may be rotated by hydraulic motor *MF* at speeds up to 300 rpm in the forward or reverse directions. With this arrangement, the output shaft may be driven at any speed in the range 500 ± 150 rpm, or from 350 to 650 rpm, by selective control of hydraulic motor speed. This represents a 30 per cent variation above and below the nominal stand input speed of 500 rpm.

The hydraulic pressure in the *PV-MF* system is a function of the torque load on the motor as imposed by the differential. Accordingly, the pump is equipped with high pressure relief valves (not shown) for protection of the mechanical and hydraulic components. These are set to open at 225 per cent of full rated hydraulic load, discharging into a supercharge pump system. A back pressure valve in the discharge line is used to trip a pressure switch connected in the clutch control circuit to disconnect the overloaded stand from the lineshaft.

Accurate stand speed regulation is accomplished through the use of master and slave hydraulic tachometers. In operation, *Fig.* 3, master tachometer *TV*1 is rotated at lineshaft speed and slave tachometer *TF* is rotated by hydraulic motor *MF*. The master tachometer acts as a pump to supply the slave tachometer. A branch line from the line connecting the output of master tachometer *TV*1 to the input of slave tachometer *TF* leads to the slide block control cylinder of hydraulic pump *PV*. Circuit pressure is supplied by supercharge pump *PF*.

Assuming that the drive is operating in a steady state condition, master tachometer *TV*1 will pump fluid through the control circuit at a rate determined by its slide block position and the speed of the lineshaft. Slave tachometer *TF* will meter this fluid and return it to the master tachometer. If the rate at which fluid is returned by slave tachometer *TF* equals the rate of delivery from master tachometer *TV*1, no control action will result. This condition corresponds to the case where hydraulic motor *MF* is rotating at the speed commanded by the setting of the slide block on master tachometer *TV*1.

If there is a volumetric difference between the master and slave tachometer flows, the piston of the slide block control cylinder for pump *PV* will move to increase or decrease the flow from pump *PV* to drive motor *MF*. When the flow from slave tachometer *TF*, direct-connected to motor *MF*, equalizes the flow from master tachometer *TV*1, the movement of pump *PV* control piston ceases. In this manner, the speed of hydraulic motor *MF* driving gear *D* is regulated according to the setting of the slide block of master tachometer *TV*1. In practice, positioning of the tachometer slide block is effected remotely by an electrical command system.

This form of stand speed control maintains output in relation to the lineshaft input. If a change occurs in lineshaft speed, no control system unbalance will be introduced and the speed of hydraulic motor *MF* will follow that of the lineshaft, retaining the same proportion. Further, system accuracy is not affected by load level. The system governs on speed, and will correct any tendency to lag or advance without regard to main system pressure. Transients of load may shift the leakage levels and require time for correction, but the response is rapid enough so that this aspect is not a problem.

Regulation of the hydraulic system has been established experimentally at 0.1 per cent. Since hydraulic drive motor *MF* is geared into the differential assembly, the over-all regulation is correspondingly improved.

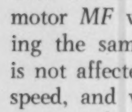
Progressive Speed Control

In addition to controlling the speeds of individual mill stands, it is necessary that the hydraulic control system provide a means of adjusting the speeds of successive stands in a progressive relationship. This is required so that the loads can be shared evenly among individual stands as the material elongates at each processing step. To accomplish this function, a series of hydraulic motors, called flow dividers, is gang-driven at the same speed, *Fig.* 3. There is one motor (*MV*1, *MV*2, etc.) for each stand. Each motor for a stand supplies fluid to the hydraulic control system for that stand. This fluid supplements the fluid received from the stand master tachometer and changes the stand speed in accordance with a preset program of speed progression from stand to stand.

Flow dividing action is obtained by setting of the thrust plates of successive variable displacement motors at progressively increasing angles corresponding to greater displacements. These thrust plate angles, and hence the displacements of the motors, are chosen so that the fluid admitted to a header by main mill tachometer *TV*2 will be apportioned by the flow dividers on a geometric progression basis. Thus, each speed control system for a stand will receive an amount of fluid from a flow divider motor calling for a different incremental speed change.

If underspeed or overspeed operation is desired, the output of main mill tachometer *TV*2 may be adjusted by remote electrical controls. This tachometer, which receives fluid from supercharge pump *PF*, will then change its delivery to the flow divider motors so as to provide up to 1 per cent overspeed or underspeed per stand, based on No. 8 or No. 9 stand (the first or second stands respectively, in the stretch reducing mill). This feature is useful when off-size skelp is being processed.

Principles employed in the mechanical-hydraulic drive system for the buttweld pipe mill are equally applicable in other types of continuous production systems for webs and filaments. Versatility of the control method is such that similar arrangements can be readily devised to meet the specific processing requirements of a variety of products.



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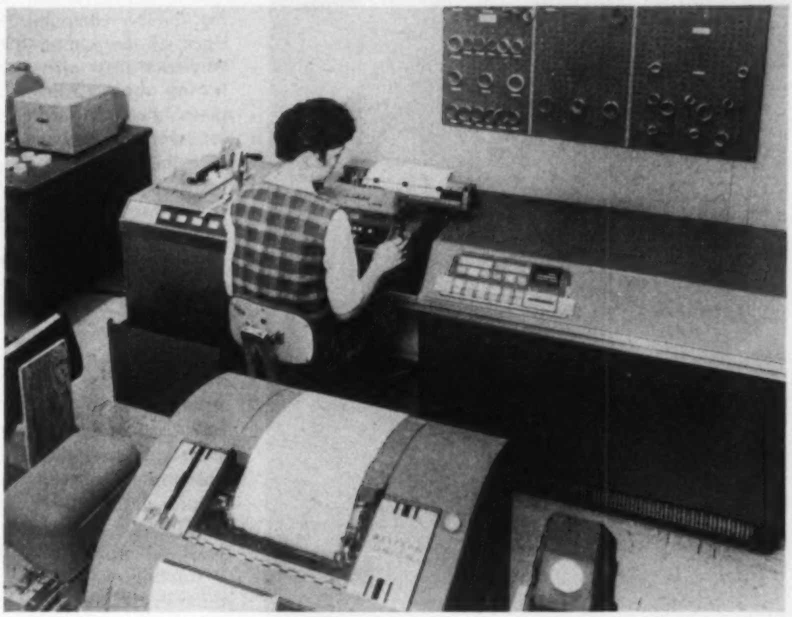


Fig. 1—Extensive communication system feeds flight hour and trouble reports from 73 United States cities and 23 foreign cities served by Trans World Airlines to the maintenance center at Kansas City. These daily reports are punched into tape and fed into computer, center, which updates all items on each aircraft in the various fleets. The computer then checks certain time-controlled parts against FAA maximum time limits and prints out the time the part change must be made and the hours of service remaining.

COMPUTER CONTROL FACILITATES AIRCRAFT MAINTENANCE

Airlines have unique maintenance problems since failure while a plane is in the air can cost human lives and entail millions of dollars in equipment loss and passenger damage suits. The latest technique for maintaining flying equipment in peak operating condition is computer control of accumulated time on airframes, engines, and time-controlled parts. In the future manufacturing industries may have to adopt similar control techniques to keep high-investment automated "must run" production lines operating at maximum output.

AIRCRAFT maintenance, a major factor affecting safety and service, is a 24-hour-a-day, 7-day-week business which has advanced technologically in recent years as much as the airplane itself. Trans World Airlines spends approximately $84 million on maintenance alone and has inaugurated a comprehensive computer controlled accounting system as part of its centralized maintenance system.

A major segment of the program involves keeping tabs on more than 10,000 powerplant parts and 20,000 airplane parts designated as time-controlled units. These units, subject to strict control by the Federal Aviation Agency, must be replaced before accumulating a specified number of flight hours. This accounting task, complicated by scheduled and unscheduled part changes, is being done on a daily basis by an electronic digital computer, the LGP-30, marketed by the Royal McBee Corp.

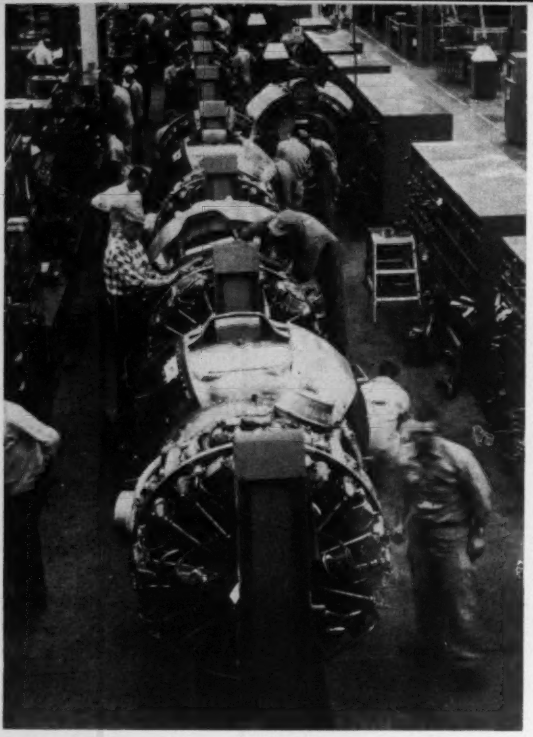


Fig. 2—The computer program for powerplants keeps track of more than 800 piston engines plus 6 to 10 time-controlled parts per engine and 188 jet engines having about 15 time-controlled parts each. Piston engines are pulled after 1500 to 2200 hours of service for overhaul, shown, during which time they are disassembled, inspected, assembled, and tested under operating conditions. At the present time about 100 piston engines and 32 jet engines are overhauled each month. This proportion will change as more jet planes are added to the fleets.

▶ Daily Reports

Using the computer in conjunction with a worldwide Teletype system, TWA is geared to receive and analyze information at a speed made necessary by the jet age. Complete, daily reports are a must. A jetliner can cross the country in five hours, return the same day, and require part changes on both coasts. These changes directly affect inventories and indirectly affect other facets of the maintenance program such as work scheduling. Jet age speed has also complicated the task of scheduling the wide variety of periodic aircraft maintenance checks. The comprehensive communications system and electronic data processing have made it possible for TWA to stay abreast of its unit time control and work scheduling programs.

Each morning, the computer is fed information on every craft in the 184 plane fleet. Located "on-the-spot" in the maintenance administration office, *Fig.* 1, rather than in a centralized data processing group, the computer accomplishes the following:

1. Speeds accumulated hours reports and makes possible daily rather than biweekly reports on time-controlled unit changes coming due. Unit time since overhaul is computed and printed automatically as changes are fed into the computer.
2. Facilitates aircraft scheduling since lead time needed to schedule engine and other unit changes has been reduced as much as 50 per cent.
3. Facilitates shop scheduling as accurate computer forecasts of future work assist in planning the shop workload.
4. Maximizes utilization of time-controlled parts which

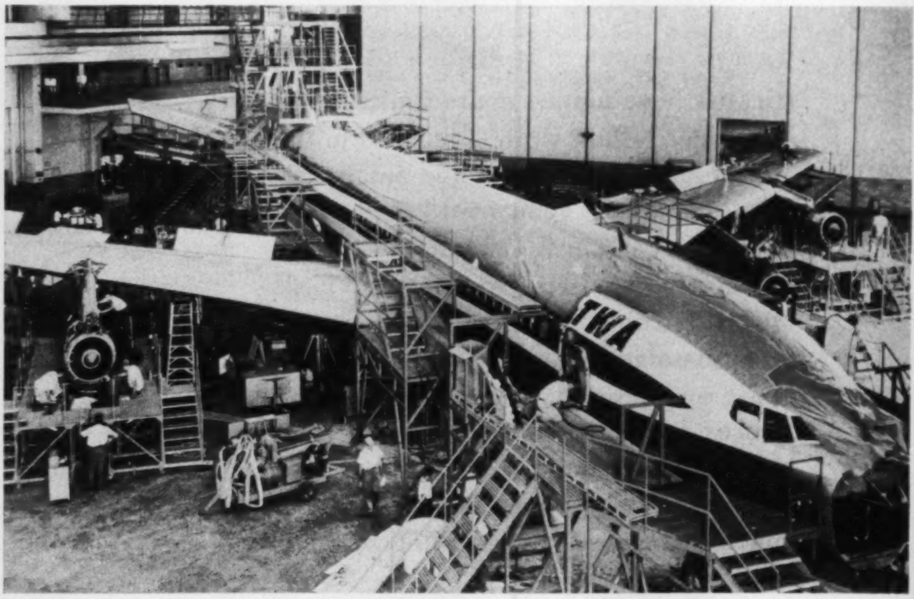


Fig. 3 — Airframes must be overhauled after 3000 to 4000 hours of service. The computer program for airframes keeps track of the time accumulated on each plane in the 184 plane fleet and updates about 80 time-controlled parts for each piston aircraft and 130 parts for each jet plane. In this view a Boeing 707 jet plane is undergoing a five-day base overhaul after 2500 hours flying time.

can now be operated to their allowed limits due to the daily updating of aircraft files.

5. Forecasts maintenance-due dates for powerplants and other components.

6. Increases data processing capacity without increasing personnel. The volume of time-controlled unit activity will increase approximately 50 per cent as the size of the jet fleets increases. Aided by the computer, the additional workload will be handled with the present number of personnel.

7. Updates part history cards for more than 30,000 time-controlled parts.

▶ Computer Programs

Three major computer programs are in use at TWA with others scheduled for the future. These include powerplant, airframe, and unit change simulation programs.

Powerplant Program: The powerplant program keeps track of more than 800 piston engines and 188 jet engines as units, plus 6 to 10 time-controlled parts per piston engine and about 15 parts per jet engine. Time-controlled powerplant parts are short-hour units whose service life falls short of the airframe overhaul times of 4000 hours for piston aircraft and 3000 hours for jets. Jet engines must be removed and inspected at least once during each overhaul cycle. Piston engines are pulled after 1500 to 2200 hours of service for overhaul. *Fig.* 2. Individual parts that are time-controlled include propellers, power recovery turbines, turbo compressors, and jet fuel controls.

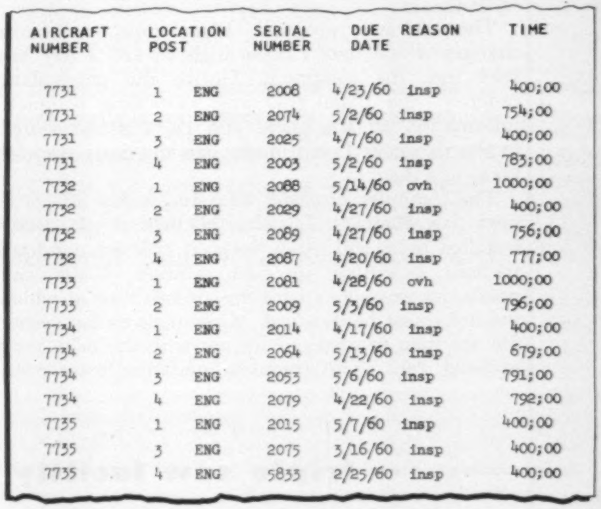
Stored in the computer's memory are the plane number, engine numbers and locations, time-controlled unit serial numbers; the time since last overhaul for all items, and basic program information on FAA allowed time limits. Each morning, the previous day's flight hours for every aircraft are received in Kansas City, punched into tape, and fed into the computer.

Input is simply the plane number and flight hours. The computer locates the right plane listing and updates all items. It then checks certain specified parts against the FAA maximum time limits and prints out the time the part change must be made and the hours left. Part removals are read into the computer daily.

Since TWA divides its aircraft into fleets based on plane types, all computer programs are run by fleets. The basic information stored in the computer on maximum time limits and various parts varies by plane, necessitating a common-plane approach. Updating the powerplant time-controlled units, searching for unit changes, and punching out a new master file takes about 90 seconds per plane, and the largest of the nine fleets—28 planes—is processed in less than 45 minutes.

Time-controlled parts that have exhausted their allowed time are returned to the Kansas City maintenance base for complete overhaul. Unit time reverts to zero hours. Parts that are removed because of a malfunction are sometimes repaired and continue to accrue time in service until reaching the FAA specified maximum. Approximately 6000 different units of all kinds are repaired in TWA shops. The production rate of these units is 430 per day. In addition, about 100 piston engines are overhauled each month. The jet engine overhaul rate is presently 32 overhauls per month and will increase to 65 jet engine overhauls per month. In addition, each jet engine is removed from the aircraft for midoverhaul inspection and maintenance at least once during the overhaul cycle. Afterward, it is re-installed and operated to its approved overhaul maximum.

Airframe Program: Time on the airframe itself and associated airframe parts such as cockpit instruments, landing gear and automatic pilots is also controlled by the computer. Tabulating time on the airframe is a straightforward accounting problem. Controlling time on airframe parts is another matter, similar only in some respects to controlling time on powerplant parts.



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AIRCRAFT   LOCATION     SERIAL    DUE     REASON       TIME
NUMBER     POST         NUMBER    DATE

  7731      1   ENG      2008    4/23/60  insp        400;00
  7731      2   ENG      2074    5/2/60   insp        754;00
  7731      3   ENG      2025    4/7/60   insp        400;00
  7731      4   ENG      2003    5/2/60   insp        783;00
  7732      1   ENG      2088    5/14/60  ovh        1000;00
  7732      2   ENG      2029    4/27/60  insp        400;00
  7732      3   ENG      2089    4/27/60  insp        756;00
  7732      4   ENG      2087    4/20/60  insp        777;00
  7733      1   ENG      2081    4/28/60  ovh        1000;00
  7733      2   ENG      2009    5/3/60   insp        796;00
  7734      1   ENG      2014    4/17/60  insp        400;00
  7734      2   ENG      2064    5/13/60  insp        679;00
  7734      3   ENG      2053    5/6/60   insp        791;00
  7734      4   ENG      2079    4/22/60  insp        792;00
  7735      1   ENG      2015    5/7/60   insp        400;00
  7735      3   ENG      2075    3/16/60  insp        400;00
  7735      4   ENG      5833    2/25/60  insp        400;00
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Fig. 4—Print out for the powerplant unit change simulation program presents an advance forecast of the engines that will need inspection and overhaul. A program designed to simulate actual engine flight time for a 30-day period is fed into the computer's memory. Data input is the current accumulated time report for each engine. Output of the computer, shown, is a report listing the plane number, engine location, serial number, estimated maintenance-due date, extent of maintenance, and estimated hours. This report is extremely valuable in planning future workloads for the maintenance shop.

Unlike powerplant parts, airframe components are long-hour units whose useful life generally exceeds the airframe overhaul period of 3000 to 4000 hours, *Fig.* 3. Previously, these parts—numbering about 80 for piston craft and 130 for jets—were updated only when the plane arrived for overhaul. Parts whose time expired prior to the next overhaul were replaced.

By putting the airframe program on the computer, an accumulated hours report is available daily. Given this information, it is now economically possible to run parts nearer to their allowed limits, changing them between base overhauls during regularly scheduled checks. Once parts have been removed, part history cards are updated. The computer, by printing out complete information on part removals, has helped cut the posting time for the cards in half.

The airframe program, flight time, and unit changes which may run as high as 125 a day are read into the computer. Unlike the powerplant program, the plane file tape containing complete information on the plane and parts is not stored in the memory. It is run through the computer one plane at a time.

The computer upgrades time and makes all pertinent part changes. It notes whether or not newly installed parts will reach the next airframe overhaul without exceeding specified overhaul limits and points out exceptions with the aircraft time at which the unit must be removed. Alterations to the master file are then printed out for use with the next day's updated run. The complete updating transaction requires less than two minutes per plane on the average. Error checks throughout the program guarantee accuracy.

Unit Change Simulation Program: As an aid to scheduling and planning, TWA has installed a unit change simulation program now used only for complete powerplants which presents a 30-day forecast of engines that will come due for inspection and overhaul. Based on assumed conditions proved by past experience, the program printout is an itemized list of engines and maintenance-due dates, *Fig.* 4. By a simple program modification, simulations can be run for a host of other parts.

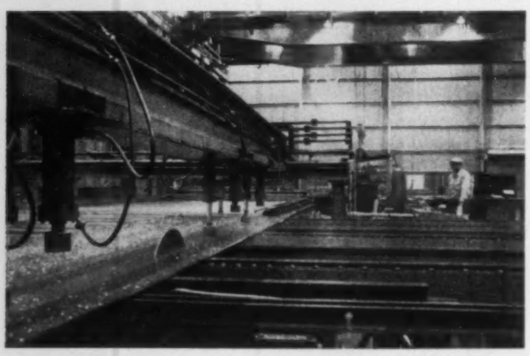
Future Programs

The current computer programs represent only a segment of the workload planned for the future. Since the time-controlled part program has produced savings in maintenance costs through maximum utilization of part life, it will be expanded to include additional parts. Parts which have not been time-controlled were replaced arbitrarily at a specified time. As time-controlled units, greater utilization of service life will be achieved. With the computer handling the necessary paperwork, such a procedure is now economically feasible.

Additional programs are planned to analyze and measure various phases of production at the maintenance center. As is true with most computer installations, potential applications materialize quickly. TWA's data processing system is geared to handle them.

triple saw facility cuts aluminum plate

AUTOMATED circular sawing machine for trimming and subdividing aluminum alloy plate has been installed in the Ravenswood Works of Kaiser Aluminum & Chemical Corp. The sawing facility was designed and built by Loma Machine Mfg. Co. Inc. in co-operation with Kaiser Aluminum's Advanced Engineering Design Section and has a capacity to handle material up to 64 feet long by 14 feet wide by 6 inches thick. Included in the facility are a 30-inch diameter, carbide-tipped rip saw which can be traversed 64 feet; a 14-foot travel crosscut saw; and a 14-foot travel end trim saw.

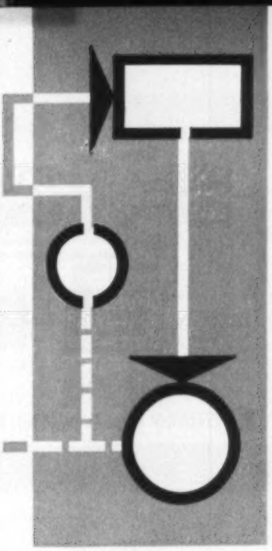


In operation, plate is delivered to a charging table by overhead crane and is moved into the rip saw path by an automatic pusher drive which cuts out as soon as a series of length-stops on the delivery table are contacted. At this time, air-operated hold-down clamps are lowered on both sides of the saw path, the length-stops in the table retract, an air-oil mist lubrication system is turned on, and the rip saw begins to make its cut. The sawblade is driven by a 60-hp motor and attains a peripheral speed of 12,000 fpm. Feed rates of 5 to 45 fpm are available during the cutting cycle, and at the end of the cut the blade returns to home at a speed of 200 fpm.

Once the rip saw cut has been completed, the hold-down clamps open, and the cut plate is moved out of the saw path by a set of belt conveyors. Subsequently, it is transferred by means of reversible delivery table rollers and is cut by the crosscut and/or end trim saws. These saws are similar to the rip saw except their length of cut is only 14 feet. After all cuts have been made, the plate is moved onto a runout table for pickup by the crane and transfer to heat treating or shipping.

Part 2

MOVING TO COMMAND POINTS



ELEMENTS OF POSITIONING CONTROLS

This final part of a two-part article completes a discussion of data input, position repeatback, amplifier, and controlled drive elements and their relationships to requirements of a process. Besides amplifiers and actuators in systems, this part notes factors concerned with supplemental control elements, cost, and general selection policy.

By **JAMES R. WALKER**, Research Director, Gemco Electric Co., Detroit, Mich.

ACCURACY of positioning can not be expected to be better than the accuracy of the error signal obtained from the position transducer. Though this is true, a machine member cannot be positioned accurately, regardless of transducer used, unless the error signal can be properly translated into movement of the member.

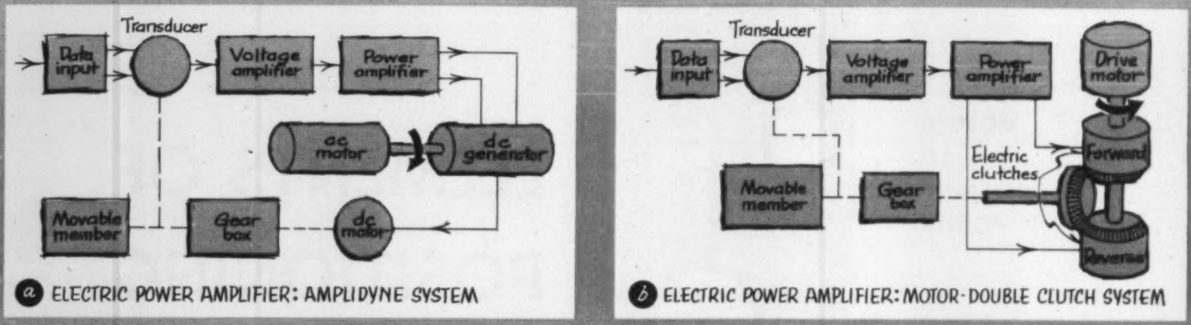
In the preceding part of this article (See Part 1—AUTOMATION, April, 1961) several means for generating error signals were presented. This discussion will point out considerations and equipment involved in amplifying and using the error signal to position the machine member.

Transducer Voltage Amplifiers

The generalized control system block diagram of *Fig.* 1 (See Part 1) indicates the use of a voltage amplifier following the transducer in the signal flow direction. The purpose of this unit is to increase the voltage and power level of the transducer electrical signal so that it can be used to control a higher power level amplifier. Generally speaking, the voltage amplifier should be characterized by the following:

1. High magnitude of voltage gain (10,000 to 100,000).
2. Low distortion for control signals lying in the null region (0.5 to 2.5 millivolts).
3. Stability of gain and linearity characteristic with changes in ambient temperature.
4. High reliability (capable of continuous operation without failure for at least 10,000 hours).
5. Low internal temperature rise and no requirement for external cooling.

Considering the applicability of these characteristics to all classes of machine control applications leads to the conclusion that each characteristic is important in determining the acceptability of a given machine and its control system. The factors of stability and reliability are especially important for machines which must be maintained in a controlled environment in order to maintain an accurate relationship of one machine section to another. Although a voltage control amplifier cannot be chosen for use in a machine control system strictly on the basis of its stability and reliability charac-



ⓐ ELECTRIC POWER AMPLIFIER: AMPLIDYNE SYSTEM

ⓑ ELECTRIC POWER AMPLIFIER: MOTOR-DOUBLE CLUTCH SYSTEM

Fig. 4—Block diagrams illustrate several types of power amplifiers that can be used in positioning systems, (*a*), electric system using the position error signal to control output of a dc generator to a dc motor, (*b*), electric system using the error signal to control opposed electric clutches, (*c*), hydraulic system using the error signal to control a proportional valve, and, (*d*), pneumatic system also using a proportional valve.

teristics, these factors are important in determining ultimate application and usefulness of the control system.

Various types of voltage amplifiers used in machine control systems employ control elements exhibiting widely varying characteristics. These voltage amplifiers, differentiated by their principal control elements, are: 1. Transistor amplifiers. 2. Vacuum tube amplifiers. 3. Magnetic amplifiers. 4. Combinations of transistor and magnetic amplifiers or vacuum tube and magnetic amplifiers. The data contained in TABLE 3 indicates fundamental characteristics of these amplifier systems.

Basic differences existing between the systems are in the factors of stability, reliability, and temperature rise. Another difference is in the necessity for external power supply equipment. In regard to the first three factors, the inherent stability of the vacuum tube amplifier, when operated under a widely varying environment, is acceptably greater than that of either transistor or magnetic amplifiers. However, a comparison of reliability data for the listed amplifiers would indicate less acceptability for the vacuum tube amplifier than for the others.

Operation of transistor amplifiers in the environmental range 13C to 43C results in negligible drift or deviation of control characteristic. In magnitude, the drift is comparable to that for a vacuum tube amplifier operated in a much wider temperature range. To achieve stabilized operation in this restricted thermal environment it is necessary to utilize temperature compensating networks within the transistor amplifier.

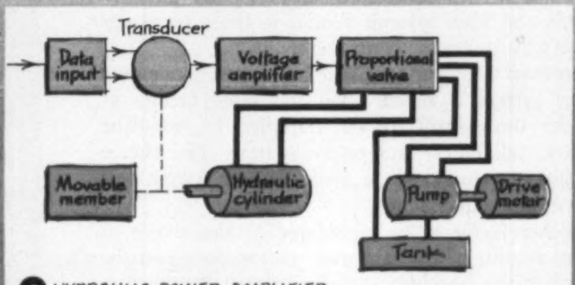
Consideration of unit temperature rise for the three basic amplifiers indicates minimal rise to be experienced with a transistor or magnetic amplifier, probably never greater than 2C above room ambient for multi-element systems. A rise of 60C to 70C may be observed for multi-vacuum tube amplifiers. In certain vacuum tube control systems employing between two and three hundred vacuum tubes, the cited temperature rise can easily be experienced in a closed cabinet.

To properly protect control components such as condensers, resistors, and transformers from this thermal environment in vacuum tube amplifiers, it is necessary to lower the temperature within the enclosure by means of a filtered air cooling system. Although such a cooling system appears to solve the related thermal problem when control equipment is initially installed, it usually follows that improper attention is given at a later time to installation of new air filters. Soon maintenance personnel are simply leaving the control enclosure open to obtain natural cooling, and as a result the equipment becomes covered with residue from associated processes and later fails to operate reliably. From this consideration, it would then appear that a transistor or magnetic amplifier, or a combination of the two, offers certain advantages in system operation providing stable gain is assured in the thermal environment of machine operation.

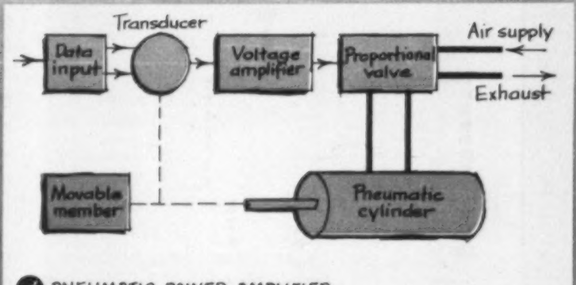
One further difference indicated by TABLE 3 is that a full wave, high gain type magnetic amplifier exhibits large time lag when operated at a 60 cps carrier frequency. Its inherent lag can approach 25 to 30 cycles of supply frequency when used in a multistage amplifier capable of a voltage gain of 10,000. As a consequence, this amplifier cannot be used in high gain control systems to be operated at 60 cycle carrier frequency. If a higher frequency carrier system can be employed with the machine control system, such as 400 cps for example, then the response time of 25 to 30 cycles is acceptable.

▸ Power Amplifiers and Actuators

Control system designers have sometimes questioned the necessity for a division of system amplification means into two sections, i.e., voltage amplifier and power amplifier. However, good reasons for this division rest upon the electrical isolation of circuits for high gain at high impedance from sections of the amplifier controlling larger power. Such isolation of one unit from the other has elim-



c HYDRAULIC POWER AMPLIFIER



d PNEUMATIC POWER AMPLIFIER

inated the possibility of unwanted or false electrical signal components combining with control data components. A division has accordingly been effected, in the 0.1 to 0.2-watt power region, between the output power level of a voltage amplifier and that of a power amplifier. Each of the power amplifier systems listed in Table 4 utilize a voltage amplifier of the types found in Table 3. Block diagrams in *Fig.* 4 indicate the arrangement of several power amplifier systems.

"Slewing rate" is a measure of the ability of a closed control loop to position a member following input data with a minimum of lag in position and time. This is one of the power amplifier characteristics known to contribute appreciably to system accuracy and stability, especially in machines continuously positioning movable members according to continuous data command.

As shown by the data in Table 4, the system using a proportional valve with a hydraulic motor provides the greatest dynamic response. For use in a system such as that for a contouring machine, the hydraulic power amplifier offers a greater degree of responsiveness than is useful on most machines due to their inherent inertial properties. Many discrete cycle positioning systems as used in table positioning for boring and drilling machines, jaw and anvil positioning in tube bending machines, and press head positioning for a multiple operation press, do not require minimum cycling time for member positioning. Here again a hydraulic power amplifier offers better response than is useful with such systems.

Successful utilization of high performance hydraulic power amplifiers in machine control systems requiring high repeatability and reliability is dependent upon the initial conditions of design and adjustment remaining constant during the useful life of the machine. Highly unstable operation, resulting in oscillation of the positioned member and loss of repeatability, often occurs when machine inertial or frictional components change during the life of the machine.

Although accuracy equivalent to that of the hydraulic system is possible with an electric power amplifier, the time response and "settling time" required for the electric motor to finally position its machine member is many times longer. For controlling a machine member characterized by large inertia in a discrete positioning cycle, there is no advantage in using a hydraulic motor due to the low responsiveness of such a machine member. Consequently, an electric motor control system can be utilized with its characteristically higher reliability and stability at a lower initial cost.

A comparison of pneumatic actuators to electric and hydraulic actuators reveals the responsiveness of the pneumatic actuator to be much the same as

TABLE 3—Typical Voltage Amplifier Charactertistics

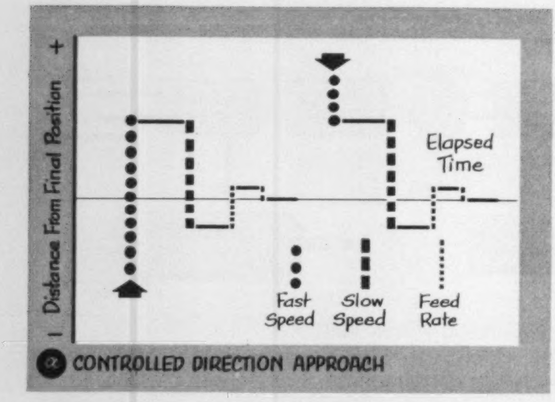
Type	Response time	Voltage gain	Power gain	Auxiliary power supply	Gain change OC to 70C	Supply frequency
Transistor	Carrier rate	10,000	2×10^7	No	32% drop	60 cps
Vacuum tube	Carrier rate	22,000	5×10^{10}	Yes	None	60 cps
Magnetic amplifier	0.075 sec	10,000	2×10^7	No	4.7% drop	60 cps
Transistor—magnetic amplifier	0.022 sec	17,200	3.5×10^8	No	6.8% drop	60 cps
Vacuum tube—magnetic amplifier	0.016 sec	18,900	3.8×10^9	Yes	None	60 cps

that for electric types. Further consideration of the pneumatic system reveals the necessity for pressure controls and filter systems similar to those necessary for use with hydraulic control systems.

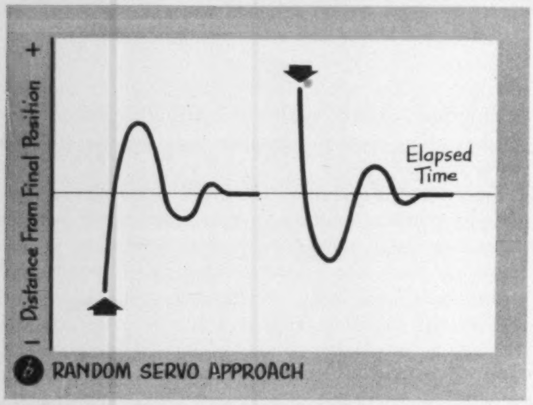
Choice of a power amplifier for use in a machine control system is based upon the same factors as cited for the control voltage amplifier, i.e., required stability, reliability, and response time. The choice of a power actuator for a given control system will involve these same factors.

Another factor to be considered in the choice of power amplifier and actuator motor for machine control is the backlash initially present in the link between the actuator motor and the positioned member. If the initial design of the machine does not warrant the use of a zero backlash system of gears and lead screw in the drive link, then it is necessary to use a controlled positioning of the machine member so that it always approaches its final position from the same direction and at the same speed.

If the necessity exists for minimization of positioning time, a lower settling time will result if a servo approach using variable speed and direction is made to final member position, *Fig.* 5. In the servo approach the member is positioned at a speed depending on error. Both controlled direction approach and random servo approach positioning cycles are used in point-to-point systems. However, only a refined random servo approach cycle can be used with continuous positioning systems.



ⓐ CONTROLLED DIRECTION APPROACH



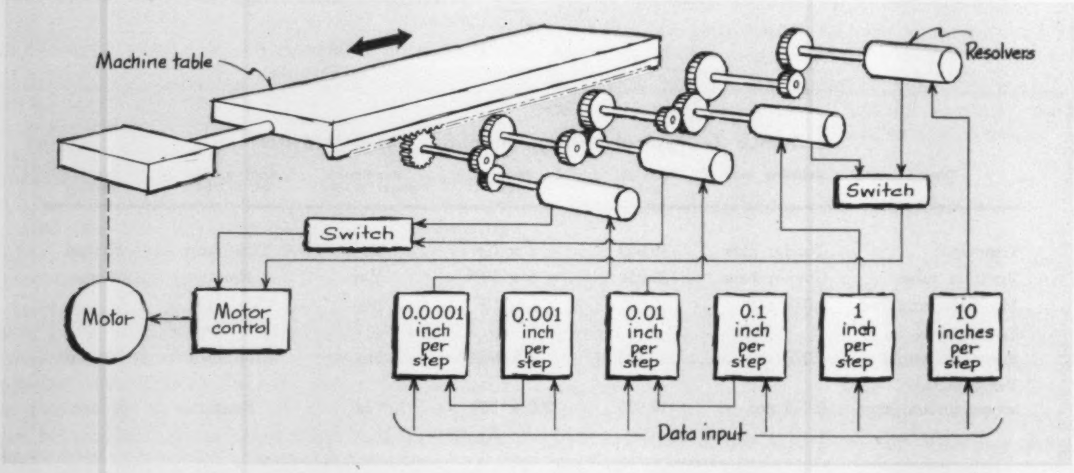
ⓑ RANDOM SERVO APPROACH

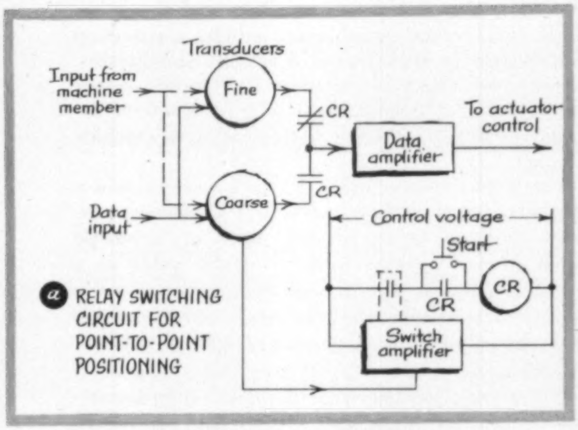
Fig. 5—Curves indicate typical responses for two basic types of positioning systems, (*a*), systems using a limited number of fixed positioning speeds and always approaching the final position from a given direction, and, (*b*), servo systems using an infinite number of speeds, with the rate of approach proportional to the error and with random direction of approach to the final position.

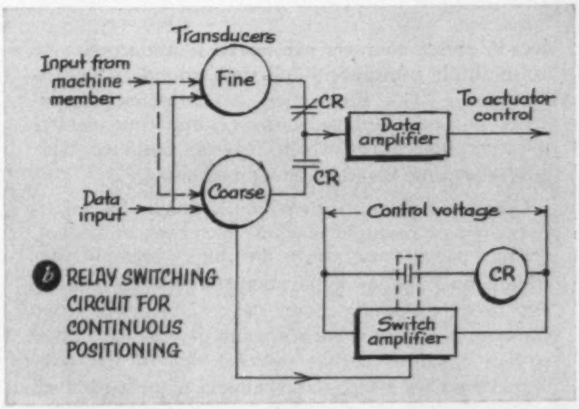
Fig. 6—Four-resolver position transducing system was designed to give a positioning accuracy of ±0.0001 inch without rotating the coarse resolver more than 180 degrees. By keeping that resolver always within its relevant half cycle of rotation, this system avoids ambiguity. The control system switches to successively finer resolvers as the command position is approached.

▶ Supplemental Control Factors

Positioning system stability and reliability are also affected by control loops within the principal control loop shown in *Fig.* 1. These inner loops or inside control blocks are employed for: 1. Switching from one transducer to another in accordance with size of control error. 2. Anticipating arrival at command point in point-to-point positioning systems. 3. Providing constant torque or force within the actuator motor loop to maintain positioning ac-




Transducers
Input from machine member
Fine
CR
To actuator control
Data amplifier
CR
Data input
Coarse
Control voltage
Start
CR
CR
Switch amplifier
a RELAY SWITCHING CIRCUIT FOR POINT-TO-POINT POSITIONING


Transducers
Input from machine member
Fine
CR
To actuator control
Data amplifier
CR
Data input
Coarse
Control voltage
CR
Switch amplifier
b RELAY SWITCHING CIRCUIT FOR CONTINUOUS POSITIONING

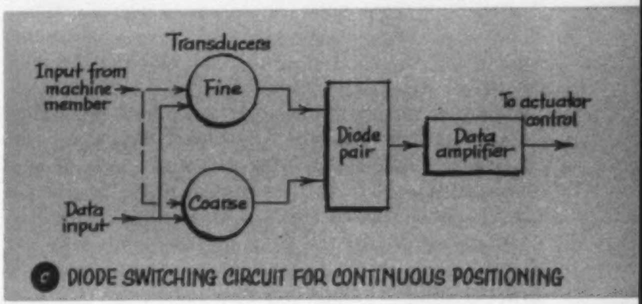

Transducers
Input from machine member
Fine
Diode pair
To actuator control
Data amplifier
Data input
Coarse
c DIODE SWITCHING CIRCUIT FOR CONTINUOUS POSITIONING

Fig. 7—Diagrams illustrate typical switching circuits used to transfer control of a positioning action from transducers for coarse increments to transducers for fine increments. Switching from one transducer to another is usually controlled by the coarse transducer.

curacy. 4. Supplying stored data according to the requirements of the control loop.

Switching of Transducers: Values of resolution obtainable for various transducers, as shown in TABLE 2 (See Part 1), are representative of those possible from a single unit operating with a low gear ratio between the positioned machine member and the transducer shaft. Usually an arrangement of transducer and driving member closely geared together will result in ambiguous data transmission from the transducer by virtue of its rotation through a multiple number of revolutions. Such rotation is permissible if at least one transducer of a multiple transducer system is always kept within its relevant half cycle of rotation. It is therefore customary for the control system designer to use a number of transducers and associated decades with a means suitable for switching from one to another. In this manner it is possible to ensure final selection of the proper half revolution of the high speed transducer to achieve desired accuracy.

The block diagram in *Fig.* 6 shows an arrangement for a multiple transducer control system to accomplish switching from one transducer to another in the basic control loop. This 4-resolver system is designed to provide a positioning accuracy of ±0.0001 inch. Such a switching system is used in most multiple transducer systems. Switching from one transducer to another is based on coarse transducer amplitude and is accomplished with relays or diodes.

Two relay switching arrangements are shown in *Fig.* 7*a* and 7*b* and a diode switching circuit in *Fig.* 7*c*. The circuit in *Fig.* 7*a* is for use in a point-to-point positioning system while the other two circuits are designed for continuous positioning systems such as those used in contour grinding or milling machines. An advantage of the circuit in *Fig.* 7*a* is that it is incapable of oscillating between coarse and fine control during a closed loop positioning cycle of a machine member. This follows from the fact that, once the amplitude of the coarse transducer has fallen below a preset switchpoint value, the coarse transducer is then prevented from commanding the positioning system until another over-all positioning cycle has been initiated.

The switching means of *Fig.* 7*b* and 7*c* allow the coarse transducer to return to command of a positioning system whenever its amplitude exceeds a preset level. For normal functions within a continuous data system this type of circuit action is acceptable. The positioned member will always be at or near the command data position, and thus the command will always be given by the fine data transducer. If, however, the positioned member should become temporarily restricted in motion, or if its power is interrupted, then it is possible for the error signal to become large enough that the command will be taken over by the coarse resolver.

In normal operation, the changeover from the coarse to fine resolver results in no system position instability. However, it is possible, after some change in machine parameters—friction, backlash, etc.,—during the life of the machine, that the originally adjusted gain factors for the coarse and fine data system may be completely unsuitable. As a consequence, an unstable condition characterized by a switching back and forth from one transducer to the other can arise. This condition can be eliminated by a readjustment of the gains in coarse and fine loops to values corresponding to the new parameters of machine operation.

Use of digital type transducers with multiple-decade preset counters can make it unnecessary to use multiple transducers and their attendant switching means. The elimination of additional components is an advantage; however, the fundamental counting inaccuracy which may be obtained with most electronic counters is a disadvantage.

Command Point Anticipation: Systems for point-to-point positioning of machine members, in drilling, boring, paper cutoff, tube bending, assembly machines, and similar applications, frequently employ two fixed positioning motor speeds and possibly two traverse gear ratios. Such systems require an anticipation signal to reduce traverse rate of the positioned member before the command point is reached.

Variation of the anticipation point with respect to the command point can result in traverse speed reductions being made too near to the command point and the final accuracy of positioning may be reduced. Amount of such variation in anticipation point can change with input data, and depending upon the data elements being used, this effect can be quite troublesome. The principal cause of unplanned variation in anticipation point is the existence of harmonic currents in synchro or resolver transducer windings. Such harmonic currents result from unequal data transformer impedances in the exciting windings of these units as the data transformer taps are switched.

Maintenance of Constant Torque: The closeness of actual position to a given command position, whether a point-to-point or a continuous positioning system is being considered, depends upon still another stability factor. This involves the maintenance of constant torque at the output shaft of the actuator motor.

When a machine is new, an electric or hydraulic actuator is adjusted to deliver constant torque to the gear train of the machine member being positioned and for the machine parameters existing with this operation. If the frictional damping component associated with the machine member becomes less as it is subjected to wear, then the loop containing the power amplifier and motor actuator can become unstable and require a reduction of loop gain or an increase of velocity stabilization. The general effect of instability within the power amplifier-motor actuator loop is a reduction of accuracy in final positioning of the associated machine member.

The block diagram in *Fig.* 8 shows a typical power amplifier-motor actuator circuit. It effectively provides constant torque at any input or command signal from a selected small minimum value to a chosen maximum. The over-all ratio between maximum and minimum lies between 100 to 1 and 400 to 1 depending upon the class of control actuator utilized.

Buffer Data Storage: A continuous positioning system requires an information or data feed rate which is dependent upon its assimilation rate, i.e., the rate of positioning allowed by the process associated with a given machine member. If the process rate varies, an unstable data requirement will be reflected to the data storage system. For example, a contouring machine cutter may not be fed into a workpiece with a uniform force due to an instability within the power-amplifier actuator loop. This will result in a second instability due to nonuniform data delivery. In turn, this instability will be superimposed upon the first, finally resulting in the machine cutter removing scallops from the workpiece. Such instabilities can be removed by adjustment to compensate for changes in condition of the cutter and changes in frictional losses of associated positioning means.

Multiple-axis control systems, which require correlation of the data and command point approach for all axes, can be subject to interloop instability resulting from the causes discussed for single-axis loops. Usually, this interaxis instability can be removed by stabilization of each control loop in an individual axis. The process of stabilization must involve rate or amplitude adjustment in all principal and sub-control loops of the control system in order to compensate for reduction of frictional components with life of the system.

▶ Cost Factors

An important consideration, especially for machines to be used in non-military operations, involves the cost of the power actuator associated with each controlled axis of a machine. Since the cost of power components for a control system can approach half the cost of the entire system, the control means utilized in this section of the system can serve as a criterion of ultimate cost.

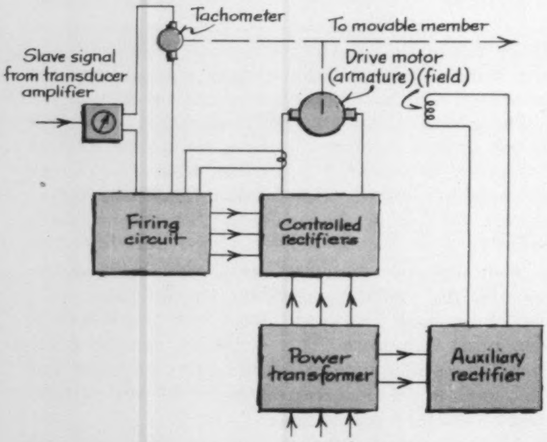


Fig. 8—Block diagram outlines a power amplifier and motor actuator circuit to provide constant torque output to the movable member. Such an arrangement is used to maintain positioning accuracy as factors like frictional damping change with wear of machine components.

TABLE 4—Typical Power Amplifier System Characteristics

Type	Electric	Electric	Electric	Hydraulic	Pneumatic
Components	Transistor or vacuum tube amplifier, relay-controlled constant speed motor	Magnetic or vacuum tube amplifier, amplidyne generator, dc motor	Transistor, magnetic, or vacuum tube amplifier, constant speed motor, double clutch	Magnetic, transistor, or vacuum tube amplifier, proportional valve, hydraulic motor or cylinder	Magnetic, transistor, or vacuum tube amplifier, proportional valve, pneumatic cylinder
Rating	4 hp	3 hp	3 hp	5 hp	80 lb force
Speed ratio	2 to 1	50 to 1	50 to 1	400 to 1	260 to 1
Time constant (second)	0.27	0.2	0.2	0.035	0.080
Drift factor (inches per hour)	Depends on voltage amplifier	Depends on voltage amplifier	±0.00009	±0.00007	±0.00005
Auxiliary power supply	None	Drive for generator	None	Hydraulic power source	Pneumatic power source
Projected life (hours)	30,000	10,000	10,000	8,000	8,000
Approach to find position	Controlled direction	Random servo	Random servo	Random servo	Random servo
Approximate cost (dollars)	1100	1900	1500	2300	1200

The relative cost of the actuators listed in TABLE 4 varies greatly and can be compared upon the basis of two factors only: 1. Ratio of speed variation. 2. Response time. To apply these criteria for cost, TABLE 4 shows that the hydraulic system can provide a speed ratio of as much as 400 to 1 with a response time of 20 milliseconds, while a dc motor-generator system can give a speed ratio of 100 to 1 and a response time of 350 milliseconds. So it is seen that a highly responsive control capable of positioning a light machine member at a high rate and over a wide variation of rates will in turn cost much more than a less responsive control.

Although both controlled direction and servo approaches can be used in point-to-point positioning systems, there is a cost advantage to be gained by using the controlled direction approach. The initial cost for the servo approach is much larger because of the higher cost of proportional components such as hydraulic control valves, hydraulic pumps, amplidyne generators, and similar components as compared to the cost of non-proportional relays.

Another factor which importantly determines control system cost is the required machine accuracy. It has been shown that the repeatback accuracy of a control system is proportional to the number of transducers used in the system and to the stability of their associated switching means and error amplifiers. Investigation of the dependency of machine and control system cost upon a repeatable accuracy factor indicates that the cost varies approximately as the 2.4 power of accuracy requirement. Hence, it is well to consider this relationship when specifying the machine and control requirements so that the accuracy of the machine does not exceed practical requirements of anticipated production.

▶ General Selection Policy

Preceding discussion has been devoted to a description of control system components and their characteristics known to contribute to total machine accuracy, stability, and reliability. An evaluation of the construction and characteristics of a modern programmed machine should be as much concerned with the control system and its components as with the mechanical portion of the machine.

As the individual concerned with final machine and system selection becomes more familiar with the characteristics of various control systems and the advantage of one over another for a specific application, it will be possible for him to more exactly choose that machine and control system which will most adequately meet the conditions of a production requirement.

It is with this in mind that the responsible individual can be advised to choose a control system, including a machine member positioning means, which will accomplish those multiple machine functions *just necessary* for the production requirement. Choice of a control system including complex functions not necessary to the production program can lead to unwarranted maintenance costs, and maintenance costs increase in more than direct proportion to the complexity of control equipment included with a given machine.

SPECIAL PARTS HITCH RIDE ON CONVEYORIZED FINISHING SYSTEM

INTERESTING paint finishing system for portable typewriter parts has been installed in a plant of Royal McBee Corp. The system is notable from two standpoints: First, its winding 1160-foot length is confined in a space above a 60 by 100-foot floor area. The space is not crammed and includes all the necessary equipment required—among which are some sizeable units including a 24-foot prime bake and 49-foot finish bake ovens, and 20 and 30-foot electrostatic painting stations. Second, the system employs a unique "reverse piggy-back" or add-on handling method that enables a volume of batch-painted parts to be worked into the main automatic finish baking cycle.

The answer to the space problem was provided by the arrangement of the finishing equipment, and the use of a flexible monorail conveyor system. The conveyors were arranged to carry the work at several elevations to accommodate all essential equipment for efficient operation in the space available—dipping down conveniently for loading and unloading.

Conveyor speed of the system, which was designed, manufactured, and erected to Royal McBee requirements by the Industrial Equipment Div. of the R. C. Mahon Co., is variable at speeds of 4 to 12 feet per minute—with a load of 20 pounds per hook. Normally about 160 minutes elapse from the time a part enters the line until it leaves fully cleaned, painted, and baked.

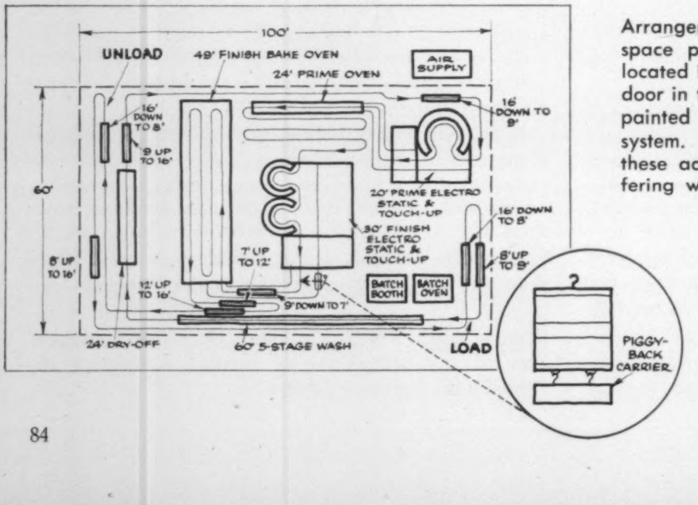
Typewriter parts are trucked to the load station of the finishing system, then hung about 24 inches apart on the hooks suspended from a 3-inch monorail conveyor. In the painting sequence, parts travel through a five-stage phosphatizing machine, dry-off oven, prime electrostatic booth, water-wash touch-up spray, 4-minute accelerated prime oven (heated to about 150F), double finish electrostatic unit, water-wash touch-up booth, then via a tunnel to the large finish baking oven. The parts are cooled in the atmosphere of the plant's finishing area while traveling from dry-off to finish painting. The whole operation, including conveyor starter motors, temperature recorders, etc., is controlled from a central motor control panel by one operator.

Both electrostatic stations in the system—the single prime unit and double finish unit—are designed with pit-mounted reciprocators and provided with clean filtered air in an arrangement which, in effect, pressurizes the booths.

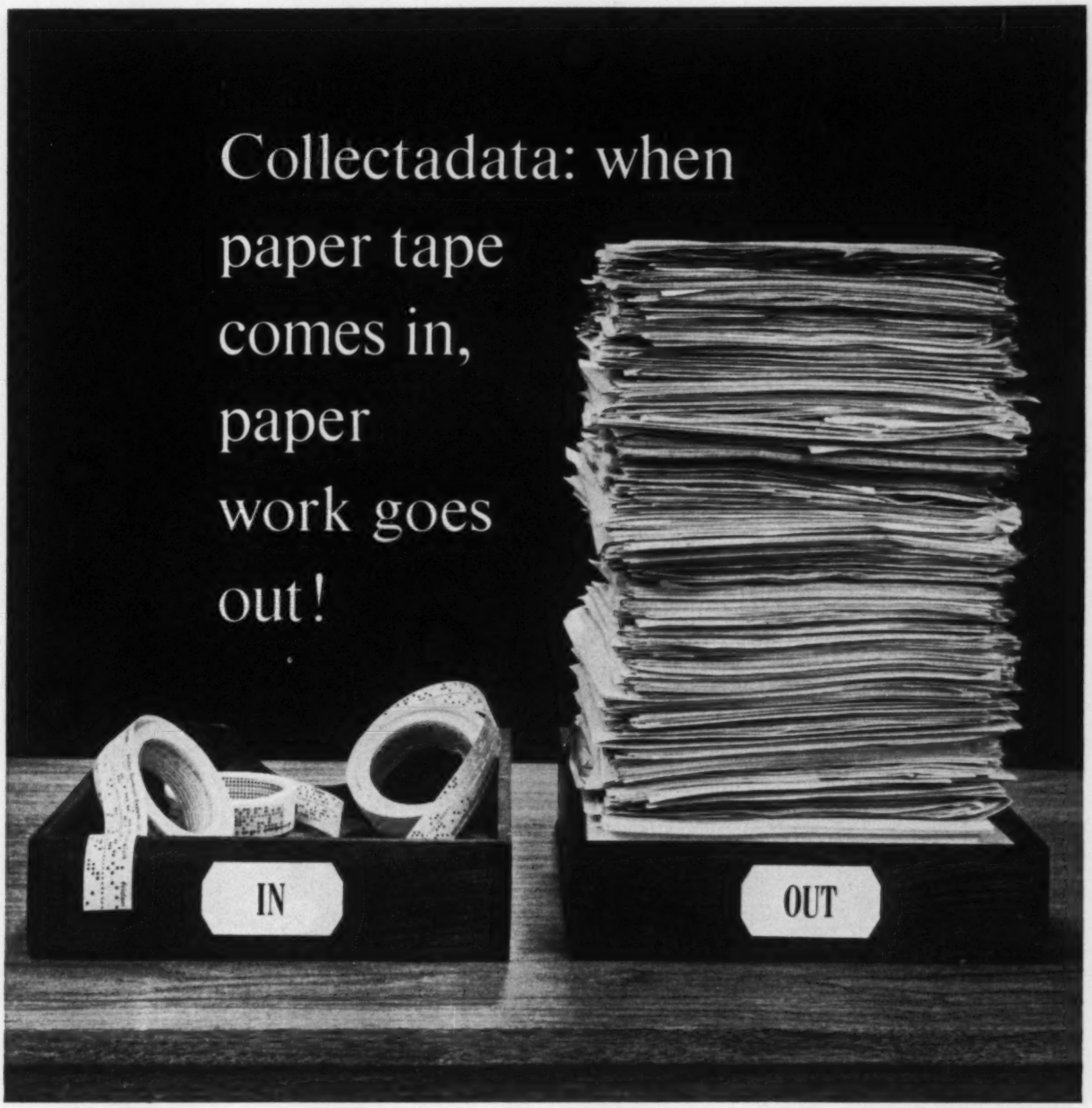
A further space saving was provided by mounting on top of the baking ovens Mahon's relatively new, lightweight heaters. The finish bake oven is a two-zone installation, normally set to provide a complete baking cycle in 50 minutes.

Other equipment installed in the limited space includes a batch spray booth and batch oven; and a stripper line consisting of two stripper tanks, two rinse tanks, and a rust preventive dip tank with exhaust facilities.

The diagram indicates what the designers did to guard against the shortage of finish painted typewriter parts at the assembly banks. It shows the point where a volume of odd-shaped parts, or those painted a different color are fed into the main system for the trip through the automatic finish baking oven. The transfer is made through a special door in the tunnel leading to the oven, just outside the exit end of the finish electrostatic booth. Also shown in the diagram is the device which made "reverse piggy-backing" possible—the suspending of odd-shaped parts under the Christmas tree hooks of the main line. The square rack device is easily suspended by a worker through the tunnel opening.



Arrangement of conveyors in three-dimensional space permits sizable paint finishing line to be located in relatively small floor area. By including door in tunnel leading to one bake oven, manually painted parts can be introduced into conveyor system. Use of "piggy back" carriers enables these additional parts to be added without interfering with normal production flow.


Collectadata: when paper tape comes in, paper work goes out!
IN
OUT

The machine at left is a Friden Collectadata® Transmitter, key to a new system of internal data collection that virtually eliminates in-plant paperwork.

The system is very simple. Transmitters, spotted in key reporting locations throughout the plant, are cable-connected to a central Collectadata Receiver. "Blank forms" are issued as pre-coded tab cards or Friden edge-punched cards. Each card becomes a "filled-in" report after the worker inserts it in the transmitter, dials in any variables and touches a key. The rest is automatic. The receiver records each report in punched paper tape, adds an automatic time code. At day's end, the receiver tapes are processed—converted to tab cards or fed into a computer to prepare complete operations reports.

Collectadata users report substantial savings in time and money. But in many applications the *speed, accuracy and efficiency* of automated data collection are even more significant. For information, consult your local Friden Systems Man. Or write: Friden, Inc., San Leandro, Calif.

THIS IS PRACTIMATION: automation so hand-in-hand with practicality there can be no other word for it.

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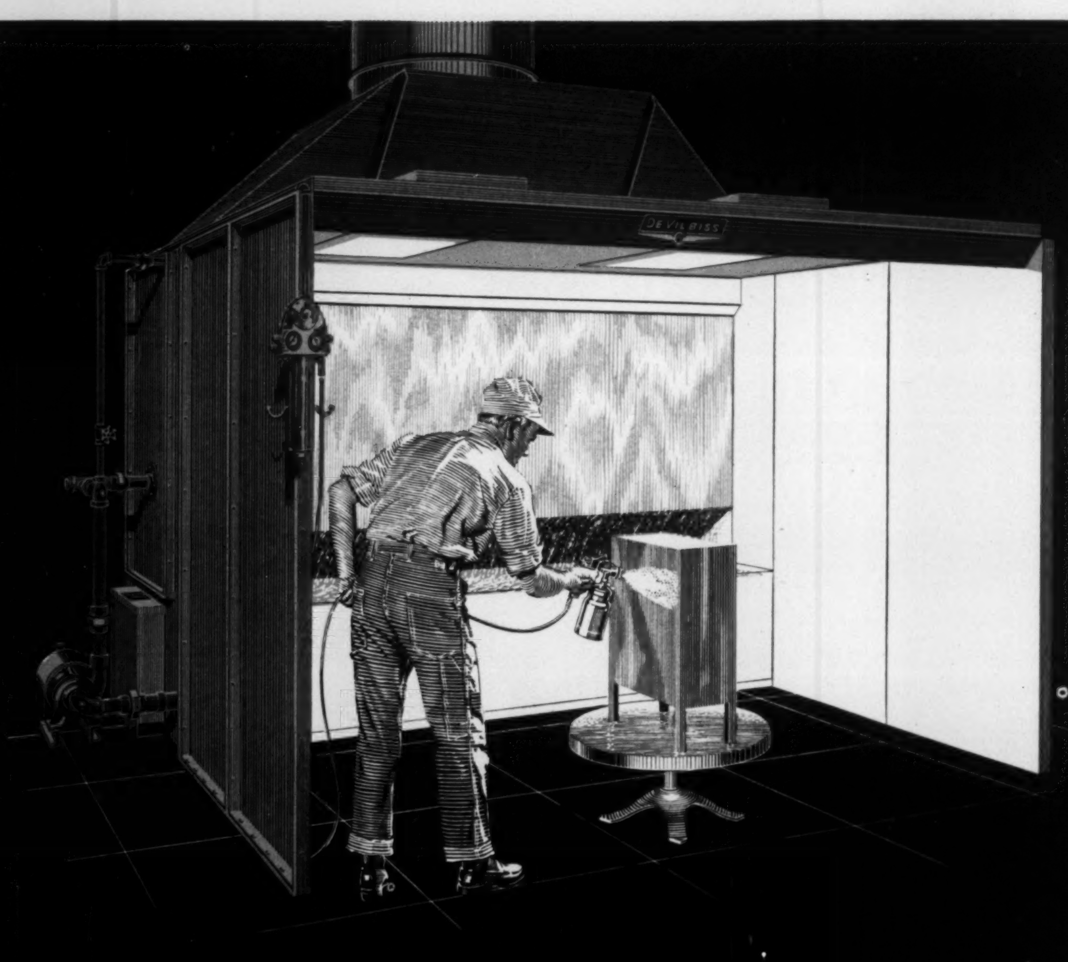
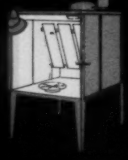
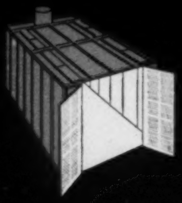
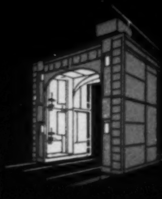
SALES, SERVICE AND INSTRUCTION THROUGHOUT THE U.S. AND WORLD

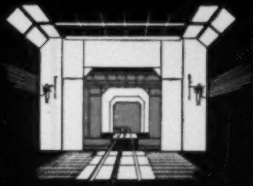
Circle 682 on Page 35




LEG-TYPE BOOTH


ENCLOSED BOOTH WITH DUST FILTERS


TRAVELING BOOTH


CONVEYORIZED TUNNEL-TYPE BOOTH

spray booths from DeVilbiss have high paint-trapping efficiency . . . easy to install, operate, clean. They're part of DeVilbiss' complete line of matched equipment for coating and finishing that includes: airless, conventional, hot-spray outfits; automatic spray, dip and flow coaters; air compressors, air and fluid hose, ovens, spray washers, air-replacement units, complete "turn-key" finishing systems.

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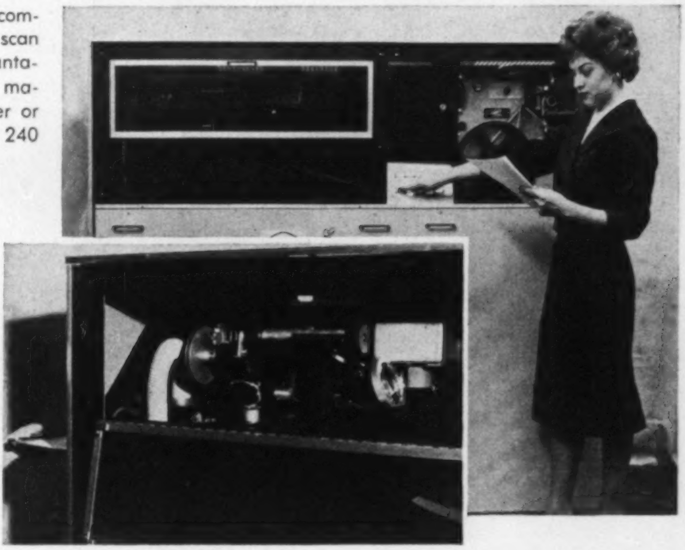
Circle 683 on Page 35

AUTOMATION new equipment

Machines and plant equipment for more automatic operations. For detailed information and literature, use card page 35.



Electronic scanner shown being started is the first commercial alpha-numerica page reader which can scan whole pages of typewritten documents and instantaneously translate what it has read into business machine language (punched paper tape) for computer or other data processing use. It reads at a speed of 240 characters, or 2½ lines a second.

A whole page of copy is being inserted into the scanning and feeding mechanism of this optical scanner, capable of reading full pages of typewritten information, single or double-spaced, or scanning entire pages in search of particular information. Impressions obtained from manual typewriters are acceptable for reading by this machine when the typewriters are reasonably maintained and a reasonable minimum of care exercised by the operators. Electric typewriter impressions are ideal. In any case, ribbons should be changed when a clear, dark, impression is not obtained.

Alpha-Numeric Transistorized Page Reader

ALPHA-NUMERIC transistorized optical scanner has been developed by **Farrington Manufacturing Co.**, Needham Heights 94, Mass., to close the information-feeding gap in data processing by eliminating laborious manual translation of raw data into business-machine language suitable for high-speed computers and automated processes. Model 10DP2 scans ordinary business documents and instantaneously translates the information it reads into punched paper tape at the rate of 240 characters—letters of the alphabet, numbers, and punctuation marks—per second. It is the first commercial reading machine to read and digest entire pages of copy. Two reading modes are available, depending on the type of document to be read. An Auto-Skip mode senses the end of grouped intelligence on a page and ejects the page at that point. A second mode, Full Scan, permits scanning of the entire page in search of isolated intelligence. Either single or double-space lines are read.

Among the many potential uses, this machine permits creation of automated systems in such areas as communications transmission, typesetting, data reduction, scientific literature abstraction, catalog-indexing and language translation. Twenty-one machines are used in assisting a major segment of the gasoline and oil industry in improving the efficiency of their credit card and billing systems. These machines read the account numbers on customer invoices and convert the invoices into punched cards for further processing. Other machines are being used for processing travelers' checks, for book club record and subscription service processing, for dividend check processing, and for cash accounting.

Information to be read must fall within a margin of 0.500 inch from any edge of the page. An automatic feed system is employed, which upon completion of reading a page, inserts the next page into the scanner. Approximately 30 pages can be stacked in the feed tray. A Soroban GP-2 punch is employed in perforating the paper tape used in the output. The same punch can be used for either the Teletype 5-level code or the Flexowriter 6-level code, either of which can be used by the machine. An odd-bit parity check is performed to ascertain that the circuitry between the interpreter and the punch is performing reliably. Scanning rate is 2½ lines per second. Power requirements of the scanner are as follows: Three 115 ±10 volt lines, 4 wire, 60 cycle, 30 amperes per leg. Total heat dissipation is 9 kilowatts. Unit has provisions which automatically compensate for normal cases of misalignment caused by faulty typewriters. It can be provided with circuitry which automatically ends a line within a preset number of characters.

Circle 401 on Page 35

another RCA system for maximum reliability

pistons and pins electronically

at the rate of 3600 per hour . .

RCA HIGH-SPEED LINE INSPECTS AND MATCH-FITS PISTONS AND PINS

PISTON LINES

1. Piston pin holes are automatically bearingized and transferred to Piston inspection machine.

2. Pistons are oriented and inspected.

3. O.D. of piston skirt is gaged in two places. Overall acceptable taper +.001" and —.000". Parts are stamped and classified into 15 acceptable categories in increments of .0002" plus over and under size.

4. Perpendicularity of axis of pin bore to axis of skirt cylinder is checked. Tolerance: .001" inch per inch; failing parts rejected.

5. I.D. of pin hole is checked at 4 points. Over and under size rejected.

PIN LINES

6. Meanwhile, RCA Non-Mar Hopper feeds piston pins into Piston Pin Inspection Machine:

7. O.D. is checked at both ends. Over and under sizes are rejected.

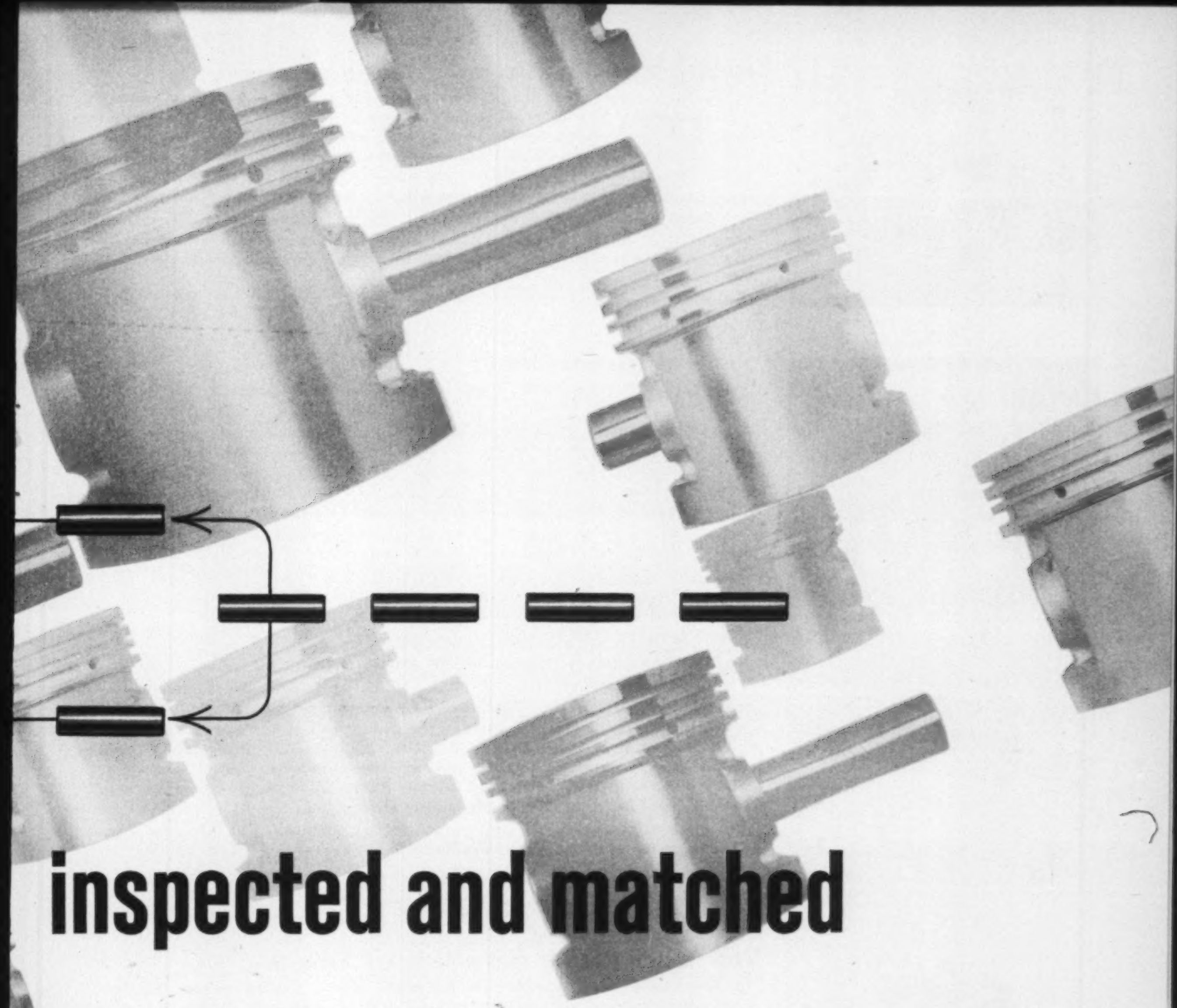
8. OK'd pins are classified into 5 acceptable categories in increments of .0001".

9. Pins pass through 5 segregating gates and are fed to non-mar type storage bins or chutes.

ASSEMBLY

A. After each piston has been completely inspected, an electronic memory device signals for the release of the proper size pin from one of the 5 chutes. Clearance of the pin in the pin hole is held to .00015".

B. Pin is fitted into matching piston. The match-fitted parts are then moved to next operation.



inspected and matched

.with accuracies never possible under statistical control!

Mass producing high compression engines to the precise tolerances required today means speeds and accuracies never before dreamed possible. Faced with this problem recently, one leading automobile manufacturer came to RCA for a high-speed automation system for their piston assembly operation. The multi-step system designed by RCA Industrial Controls provides for precision electronic inspection, segregating and matching of pistons and pins.

In this high-speed quality control system, the output of two piston inspection lines is match-fitted to the pins coming from pin inspection line at rates up to 60 assemblies per minute! Far better engine performance from finished parts and longer operating life are the result.

With the increased emphasis on greater accuracy and trouble-free performance, many companies are supplanting statistical quality control with RCA automatic inspection systems to inspect each and every part. Whatever your requirements... a fully integrated automatic system, or a simple mechanization of a single operation, RCA offers the most versatile range of equipment available.

Why not get the complete story? Write RCA Industrial Controls, 12611 Arnold Avenue, Detroit, Michigan, or see your RCA Representative.

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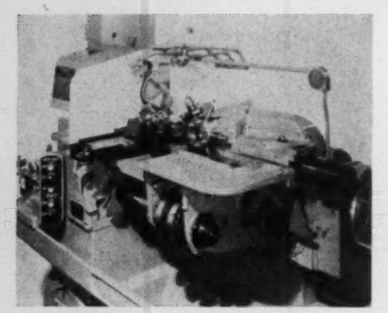
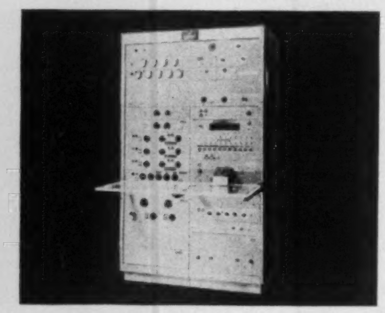
Circle 684 on Page 35



CHUCKING MACHINE FEATURES NEWLY DESIGNED AIR CHUCK

Machine is designed to handle irregularly shaped parts such as forgings, castings, extrusions, and cold-headed parts as well as simple slugs. Newly designed Skinner air chuck has a 3-inch capacity, and a 4-inch swing over cross slides is provided. Chuck jaw movement is 3/32 inch on diameter allowing over-the-head chucking where required. Spindle drive is by means of gears and chains from a 7½ hp motor. Fifteen spindle speeds on high range are provided with a top speed of 2095 rpm for those jobs requiring a spindle reversal during the cycle. Two higher speeds up to 2905 rpm are available for nonreversing applications. Both automatic and manual controls for the chuck operation are furnished as standard equipment. **Brown & Sharpe Mfg. Co.,** Providence 1, R. I.

Circle 402 on Page 35



AUTOMATIC TRANSISTOR TESTER

Automatic transistor tester is designed to process every parameter that can be tested at a rate of 750 per hour. Units tested include: All PNP and NPN transistors; silicon, germanium, alloy function, drift, diffused mesa and surface barrier types, also power transistors and semiconductor diodes. This testing device can skip, hold, or delay any or all of the tests. Measurements are made with accuracy of 1 per cent. Programming can be done on a go-no-go basis. Only *pass* units remain in the test set. Automatic reject-eject device discharges failures. Optional features include digital readout. Recordings of bias setting, parameter reading and delay between tests can be made on IBM 526 printing summary punch. **Contronics Inc.,** 37 Leon St., Boston, Mass.

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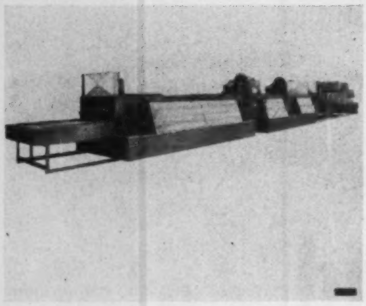

WASHING AND DRYING METAL SHEETS PRIOR TO BONDING

High production wash-rinse-rinse-dry machine has been developed for cleaning steel and aluminum 22 to 30 Ga. sheet before bonding to plywood backing. To ensure thorough cleaning, rinsing, and drying of the sheets, this machine, operated at a mean conveyor speed of 25 fpm, had to be built 119 ft long. Features incorporated into the unit include: A snow plow type air blowoff between stages to prevent carryover of solutions from one stage to another; a separate conveyor through the high temperature, insulated, gas-fired dryer to minimize water carryover into the dryer; nylon covered hold-down cables through the spray sections to prevent damage to light gage sheets while being conveyed through the machine. **Alvey-Ferguson Co.,** 6025 Disney St., Cincinnati 9, Ohio.

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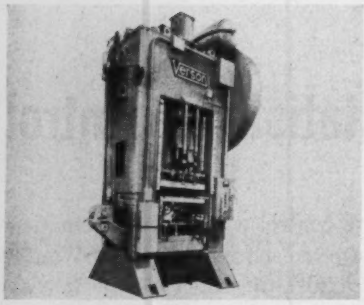

PRESS COMBINES DOUBLE FEED WITH IMPACT MACHINING

Featuring a double transfer feed mechanism, this cold extrusion press has been developed to produce automotive wrist pins. It feeds slugs from a single hopper to two Transmat feed mechanisms. In parallel transfer operations, the material is moved to each station by mechanical fingers. Starting with precoated slugs 0.941 inch in diameter by 1⅜ inches in length, the material is checked for size in the first station. They are extruded at the second station. The third station performs draw-wipe and pierce, and the finished part is unloaded through the bottom of the die. The finished wrist pin has an OD of 0.866 inch, ID of 0.541 inch, and a length of 2.795 inches. **Verson Allsteel Press Co.,** 9347 S. Kenwood Ave., Chicago 19, Ill.

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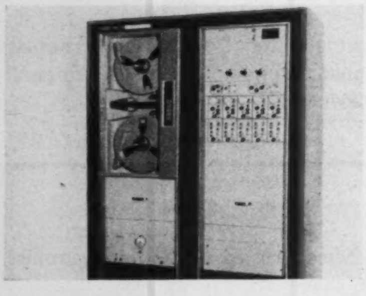

SOLID-STATE MAGNETIC TAPE SYSTEM

Laboratory analog recorder 7500 can accommodate up to 14 channels of FM record and playback in one rack. Six tape speeds can be selected from the front panel, and tapes as thin as 0.65 mil base can be handled. Two basic tape transports are available. One uses a tape width of ½, ¾, or 1 inch; the other, width of 1, 1¼, 1¾, or 2 inches. This all-transistor record/reproduce system accepts analog inputs within a bandpass of dc to 10 kc for as much as one hour of continuous recording. Incorporated in the unit are a re-record output for making duplicate tapes and a power output section to permit the use of direct writing instruments without the need for additional amplifiers. **Industrial Systems Div., Minneapolis-Honeywell Regulator Co.,** 10721 Hanna St., Beltsville, Md.

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WATCH THIS SPACE

In a moment a new satellite will streak into view. Bell Laboratories may help guide it into orbit, for few are so eminently qualified in the science of missile guidance. Bell Laboratories' Command Guidance System has guided such trailblazers as Tiros and Echo into precise orbits. The same system will guide more new satellites into predetermined orbits as Bell Laboratories continues pioneering in outer space to improve communications on earth.

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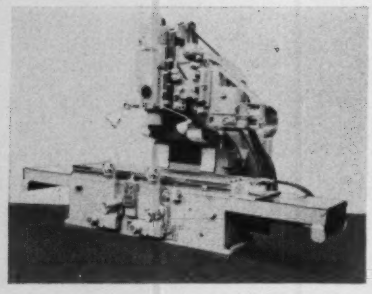

VERTICAL MILLING MACHINE FEATURES 60-INCH TABLE TRAVERSE

Vertical Hydro-Tel milling machine has the versatility and adaptability for general purpose manually controlled milling, die sinking, automatic profile milling, and multiple spindle production milling. The machine has a new cross slide and vertical head, with horsepower ratings 50 to 100 per cent greater than before. Table and cross slide feeds are infinitely variable from 1 to 25 ipm or ½ to 12½ ipm; vertical head feeds range from 1 to 15 ipm. There are 16 spindle speeds, six optional ranges for the 10 and 15 hp drives, and four for the 20 hp drive. **Milling Machine Div., Cincinnati Milling Machine Co.**, Cincinnati 9, Ohio.

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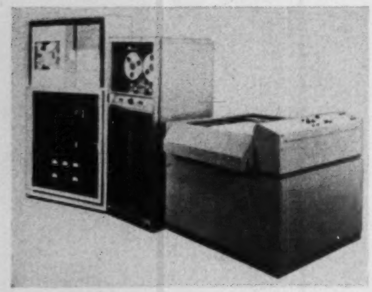

DATA TRANSLATORS PRESENT INFORMATION GRAPHICALLY

Available in a wide variety of input-to-output combinations, these data translators utilize Model 210 systems as basic translators. Functional modules, in the form of direct-coupled logic cards, are incorporated into a system to tailor it to a particular application. All solid-state modules are easily replaced in the field, permitting system modification as requirements change. Input-to-output variations include: Magnetic tape-to-magnetic tape, magnetic tape-to-punched tape, punched cards-to-magnetic tape, magnetic tape-to-plotter, and punched tape-to-magnetic tape. Applications include the graphical presentation of any information most conveniently stored on magnetic tape in digital computer format. **Systems Div., Beckman Instruments Inc.**, Technical Publications Dept., 325 N. Muller Ave., Anaheim, Calif.

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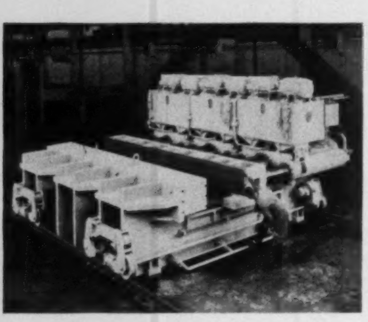

HORIZONTAL FORMING PRESS WEIGHS 400,000 POUNDS

Large horizontal forming press is used to form frame members, mold boards and other components for giant earth moving equipment. It has a total ram pressure of 2550 tons, ram travel of 6 feet, and in a single operation forms steel in pieces larger than previously possible. The unit is composed of three 850-ton presses arranged side by side and provides the advantage of working the three presses in unison or of operating each unit independently for normal jobs. A track allows the outside units to be moved to desired locations. This press is 20 ft wide when the three machines work as a unit. Length is 27 ft and height is 12 ft. Each unit has a 60 hp motor and starter, and each motor drives a 44.6 gpm pump. **Lake Erie Machinery Corp.**, 500 Woodward Ave., Buffalo 17, N. Y.

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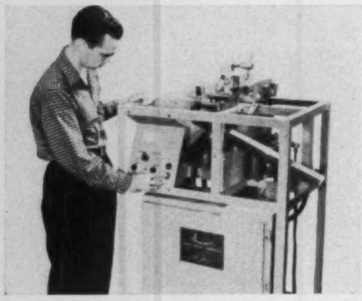

ELECTRONIC WEIGHT COMPARATOR

Production line electronic weight comparing system automates the selection and screening of parts and materials by weight comparison. When used in a processing or production operation it handles a continuously moving stream of parts or materials, rapidly weighs each item individually, automatically compares this weight to within plus or minus one gram of a predetermined proper weight and either accepts or rejects the item depending on how it meets the weight requirement. As presently designed, the system handles items weighing up to five pounds. Typical applications include handling and weighing of metal billets and slugs to determine if the volume of metal is within acceptable limits for an extrusion process and identification of different metals presented in slugs of similar volumes. **Atronic Products Inc.**, West Conshohocken, Pa.

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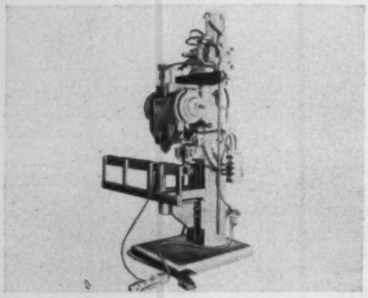

HYDRAULICALLY POWERED RIVETING MACHINE

Machine has a 12-inch throat depth and is designed to automatically feed and set either of two length rivets up to 5/16-inch diameter. Operating on only 80 psi air pressure its hydraulic booster and cylinder delivers a setting force of approximately 10,000 lb. This setting force is applied only during the last downward ½ inch travel of the spindle. The first 3½ inch of down stroke and the entire retract stroke use only low pressure oil. Maximum force is provided at the needed moment without the bulk and cost of expensive pump equipment. Use of hydraulic power provides ease of adaption of the machine to a combination with other Multi-Head riveters to set more than one rivet at once. **Tubular Rivet & Stud Co.**, Quincy 70, Mass.

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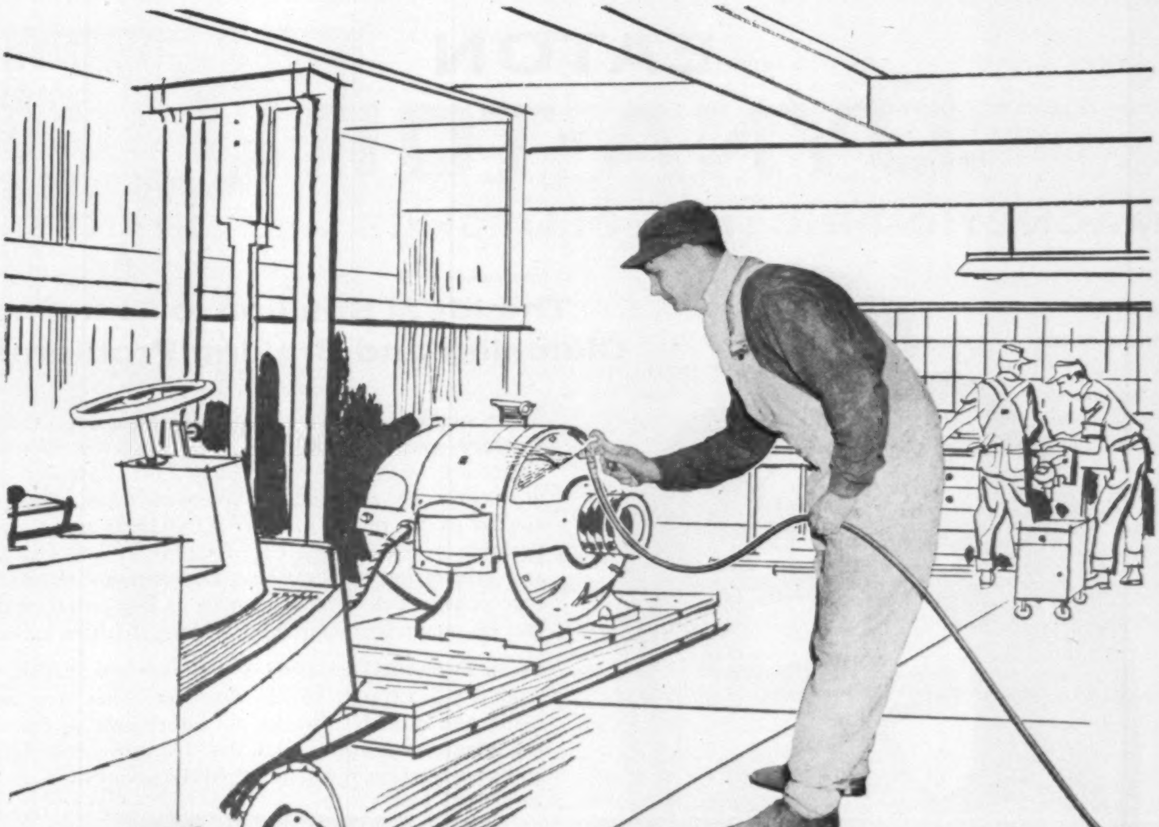

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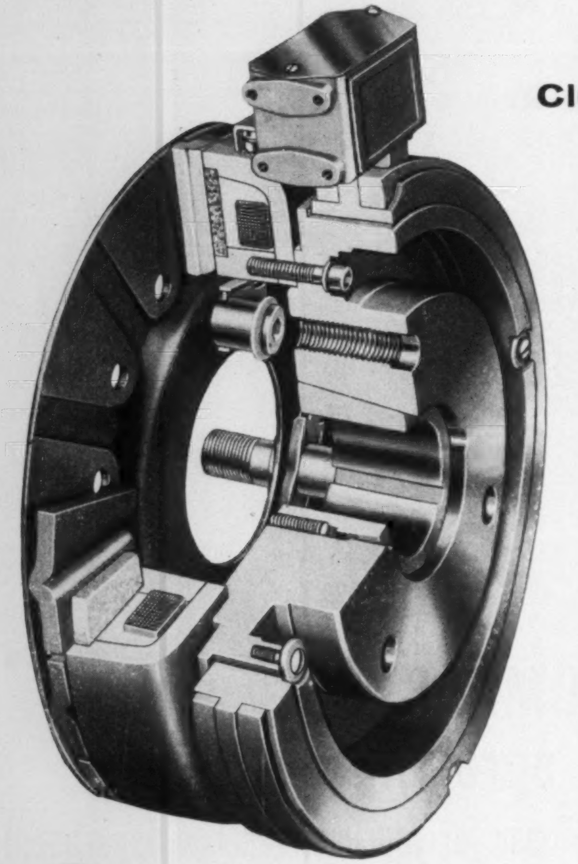


The Ideal Solution to Exacting Clutching and Braking Problems

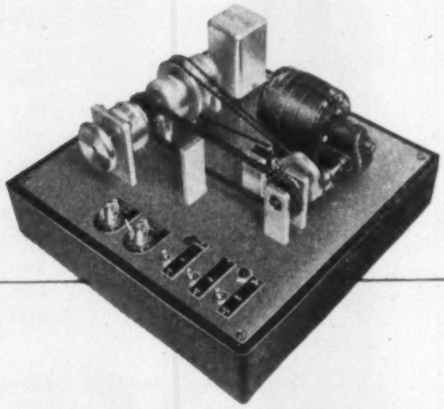
These highly responsive, trouble-free units provide accurate control of intricate automatic machinery. Operating on 6, 12, 24 or 90 V.D.C., Dyna-torQ units may be actuated by micro-switches, photoelectric cells, relays or any "ON-OFF" signal to perform a wide range of functions in processing and fabricating applications. The compact rectifier type control converts AC power to DC power and may be remotely mounted out of busy machine areas.

Eaton Dyna-torQ Clutches and Brakes are available from 1¾" through 15" in diameter. They may be easily and quickly installed on either new or existing plant equipment. Exclusive features of design and construction mean worthwhile savings.

HP @ 1800 R.P.M. *(Typical Application)*

MODEL	HP	MODEL	HP
302	1/20	308	7½
303	⅓	310	10
304	1	312	20
305	2	315	25

Dyna-torQ Distributors in many principal cities carry Dyna-torQ Clutches and Brakes in stock for immediate delivery.



Ask your Dyna-torQ Distributor to demonstrate Dyna-torQ in action and see for yourself the many possible applications for Dyna-torQ in Motion Control and Power Transmission.

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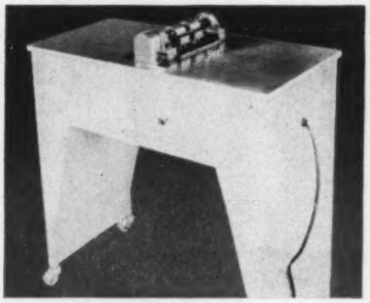

LEAD STRAIGHTENING MACHINE

Machine was designed for use by electrical component manufacturers in straightening bent terminal leads of any type cylindrical bodied component. It was engineered specially for short run, divergent size, straightening requirements experienced by many manufacturers of resistors, capacitors, and other cylindrical bodied components. This machine is capable of processing about 3000 pieces per hour and is designed as an easily portable unit which may be operated either standing or sitting, and from either side. The unit is provided with a variable speed drive which facilitates optimum straightening for each different diameter lead wire to be handled. **Sigma Engineering Service Inc.**, Box 111, 26 W. Warren Rd., Custer City, Pa.

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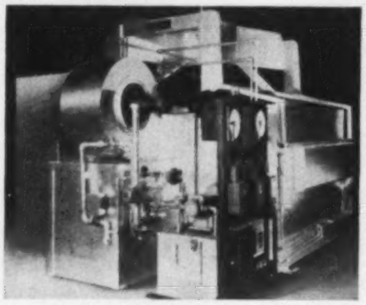

STEEL SHEET FLATTENING FURNACE

Circulating type steel sheet flattening furnace is especially designed for easy operation. It is available as gas-fired or electrically heated. Doors open in front and in back, allowing the furnace to be used at both ends. Inside are two cast-iron dies. The bottom die is stationary. The top die is mounted to a hydraulic cylinder with a ball joint. Various combinations of controls may be obtained. The control in the air stream is proportional, and in series with a controller in the die. Temperatures can be held to ±5F in a range of 250 to 1100F. **Waltz Furnace Co.**, Dept. 51, 1901 Symmes St., Cincinnati 6, Ohio.

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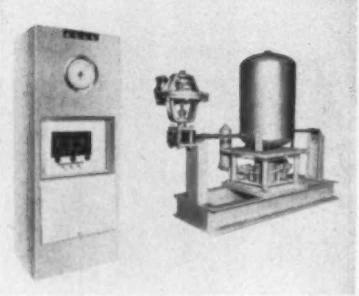

SPECIFIC GRAVITY MEASURING SYSTEM

Continuous, in-process specific gravity measuring system is designed for use with liquids, solutions, slurries, suspensions, emulsions, whips, and creams. It operates without radioactive devices or complex mechanical transducers. Its output signals can be used for indication, recording, or control purposes. Accuracy of the system is better than 0.25 per cent. Repeatability is 1 part in 2000. Pneumatic signal output gives wide flexibility and range; output pressure can be 3-15 psi or 5-40 psi, read on a scale calibrated to 0.1 per cent. The signal is essentially stepless, which permits smooth control. **Weighing and Controls Inc.**, Industrial Park, Hatboro, 773, Pa.

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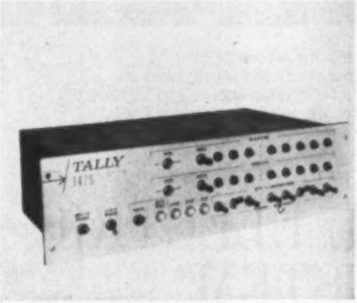

PUNCHED TAPE VERIFIER AND DUPLICATOR

Instrument is used in conjunction with a line of punched tape readers and perforators. It automatically duplicates and verifies or verifies and duplicates error free tapes in one operation. Perforated tapes from 1 through 8 channels in any code structure can be processed. Specifications: Tape duplication—5, 6, 7, or 8 channels, any code, 60 characters per second; verification—5, 6, 7, or 8 channels hole for hole, any code, 60 characters per second, automatic stop with error character on display, in neon indicators simulating bits. Verify duplicate—5, 6, 7, or 8 channels, any code, 60 characters per second, failure to verify automatically stops the duplication function without punching an error character. **Tally Register Corp.**, 1310 Mercer St., Seattle 9, Wash.

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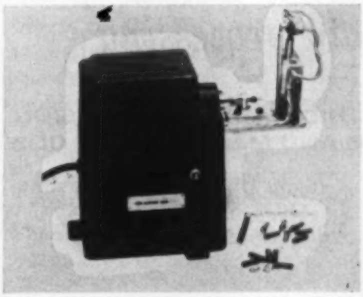

ASSEMBLY PRESS CLAMPS C-RINGS TO SHAFTS

C-Ring assembly press is designed to speed potentiometer component assembly. It holds prestacked rings and automatically clamps the rings to centerless-ground potentiometer shafts. The press accepts any size retaining C-ring and is easily loaded making it a versatile tool to handle various size requirements in rapid succession. As an optional accessory, a foot switch may be used to operate the press if required. Users may specify size and style of C-ring, shaft diameter from 1/10 to ½ inch, and length of shaft to recessed slot which can be from a minimum of 0.020 inch to maximum 3 inches. **Altomac Corp., Subsidiary, Technology Instrument Corp.**, 863 Washington St., Canton, Mass.

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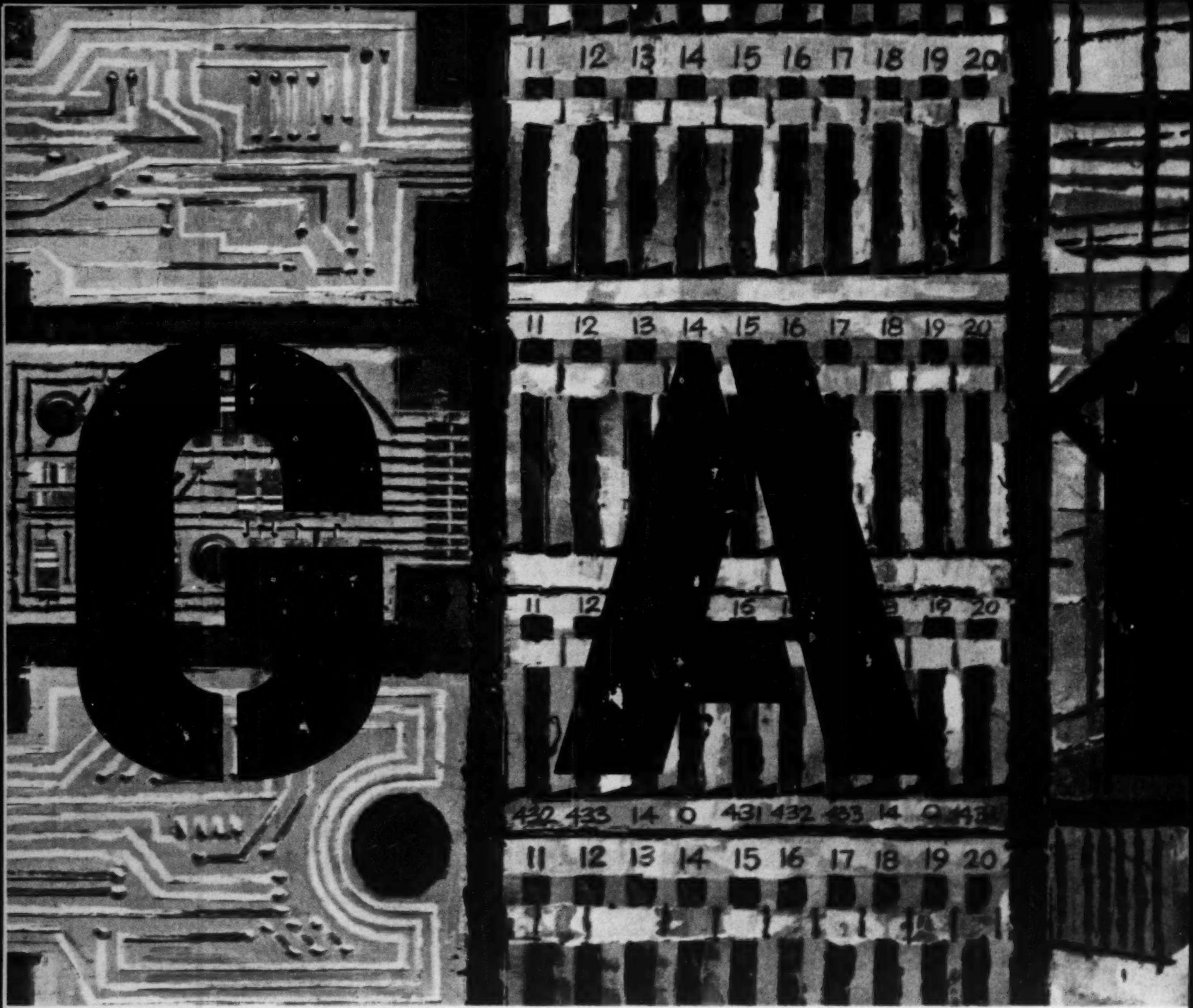


G Gathers automatically the information the operator needs to supervise the plant.

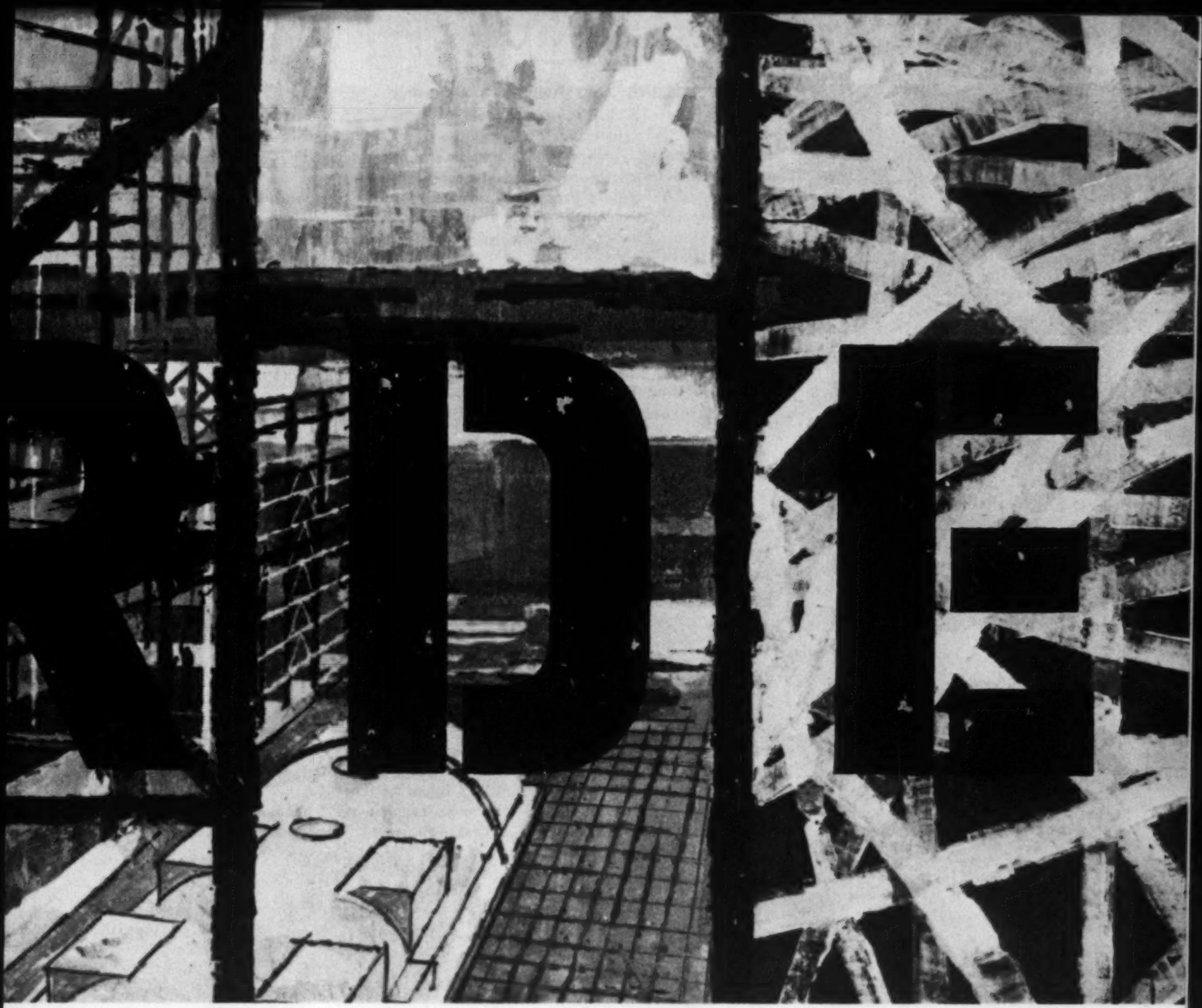
A Alarms off-limit quantities... automatically warns when an unsafe value occurs and logs all points exceeding pre-set limits.

NEW GENERAL ELECTRIC COMPUTER SYSTEM

designed solely for electric utility steam power plant data processing

HERE'S HOW GENERAL ELECTRIC'S ADVANCED DESIGN SYSTEM LOWERS OPERATING AND MAINTENANCE COSTS...

GARDE is General Electric's process computer system designed especially to meet the problems and needs of electric steam plant data processing. The GARDE system gathers, alarms, reports, displays, and evaluates data from several



R Reports . . . automatically prepares a complete log of all operating conditions hourly or on demand.

D Displays . . . continuous visual display of any input or computed value that the operator chooses.

E Evaluates . . . over-all plant and key component performance hourly—or on demand.

hundred inputs located throughout the plant. It warns of abnormal deviations in those process conditions which cause equipment stress and inefficient operation. Early detection of these saves dollars in equipment maintenance and increases operating efficiency.

In addition, the GARDE system checks itself—detecting faulty sensors and other components. Its continuous reports are invaluable in periods of rapid operational changes. One of its provisions guides the operator through complex plant operating routines, helping him avoid errors and resultant equipment outage.

GARDE system evaluates these key plant operations: Boiler efficiency • Turbine Generator Heat Rate • Station Heat Rate • Correction of Heat Rates to Bogey Conditions • High Pressure and Intermediate Pressure Turbine Efficiency • Feedwater Heater and other Equipment Performance • Condenser Performance.

General Electric was able to design the GARDE system because it leads all manufacturers in process computer systems installed or ordered by the utility industry. The near-million man-hours of application and research in its design were spent in implementing systems for users. Out of this experience, came the GARDE process computer system.

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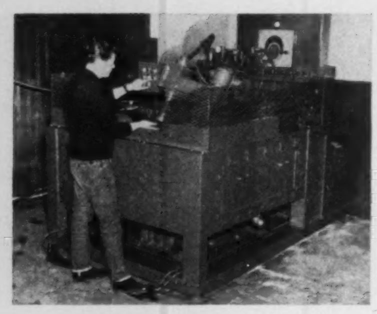

FIXED DEBURRING AND FINISHING MACHINE

Heavy-duty 75 hp Mechamatic unit, the MM-2-High Speed, 2 spindle unit has been designed for low production of a multiplicity of parts and/or high production of a single component. It has two independently operated spindle heads which allow the machine operator to service one spindle while the opposite spindle is in process. Parts are mounted in spindle fixtures, air-operated, which are submerged while rotating, in a fluid abrasive mass which travels at the rate of approximately 200 SFM and simulates a form fitting grinding wheel, regardless of the piece part. The machine (illustrated) at a 15-second time cycle, will produce 240 pieces per hour at 100 per cent efficiency. It has capacity of up to 6-inch diameter piece parts. **Mecha-Finish Corp.,** 1950 Hopkins Rd., Sturgis, Mich.

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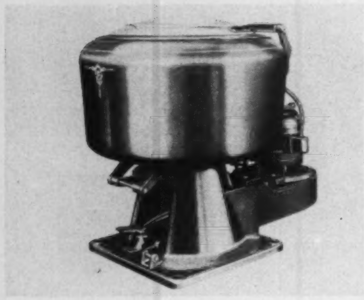

CHIP WRINGER REDUCES COOLANT COSTS

Coolant and cutting oil can be reclaimed from metal chips, turnings, grindings, and borings with illustrated chip wringer. By running the chips for not more than 3 minutes in this device, at least 90 per cent, and as much as 99 per cent, of the cutting oil remaining in the chips is removed. The wringer reclaims as much as 2.94 gallons additional cutting oil from every 100 lb of metal chips. In not more than 3 minutes, the unit reclaims again as much oil from every 100 lb of chips than can be reclaimed in from 12 to 24 hours with a settling tank. Features of the device include: Safe operation, sturdy sheet-iron basket, and vertical motor V-belt drive with pushbutton operation. **Olson Filtration Engineers,** Cincinnati 12, Ohio.

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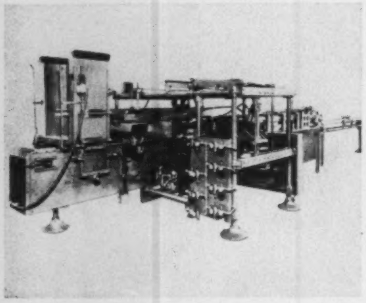

CASE SETUP AND PACKER WILL HANDLE VARIOUS SIZE CANS

Machine incorporates a pneumatic 3-lane divider and a feathered pusher for loading. It is engineered for continuous high-speed production of 25 cases per minute without an operator. Cans are fed to the machine in a single line and pneumatically positioned in the proper lane. Lock-outs hold back the cans in each lane—they are then loaded by a feathered pusher permitting immediate infeed of next case. All operations are interlocked electrically. Unit is adjustable to pack gallon and 5 quart cans into end-opening cases with no downtime and will handle all cases of standard specifications. **A-B-C Packaging Machine Corp.,** Clearwater, Fla.

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DIGITAL CONTROLLED DRIVE SYSTEMS

Special purpose digital controlled drive systems when applied to cut-to-length lines are capable of precise cutting to any desired length, calibrated in increments as fine as 1/64 of an inch. They feature extreme accuracy and may be programmed by cards, tapes, or dials. The systems can be built with memories and with the ability to calculate. They are all-environment in application, and specifically designed for individual applications. Typical applications for these systems are cut-to-length lines, classifier lines, test stands, and press feeders. All drive systems in the line are provided with built-in test equipment for fast system checks. **Reliance Electric & Engineering Co.,** 24701 Euclid Ave., Cleveland 17, Ohio.

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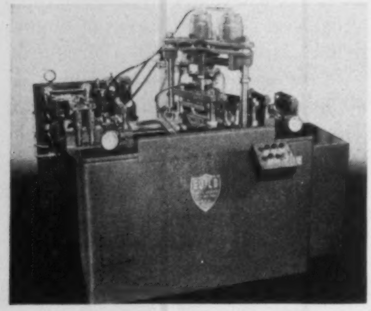

COMBINATION SHEAR AND END WELDER

Designed to provide continuous strip for roll forming, tube manufacturing, punch press operation, and coil-strip processing lines, automatic combination shear and end welder utilizes mash seam process to join coil strip ends for continuous processing lines. Model RD-907 features a fast cycle capacity. Complete operation time for clamping, shearing, and welding will range from 15 to 25 seconds, depending upon material thickness and width, increasing production as much as 30 per cent. Machine welds continuously from edge to edge of the strip, resulting in a joint with parent metal strength. A coil-end detection unit is available as an optional feature. **Guild Metal Joining Equipment Co.,** 7280 Wright Ave., Bedford, Ohio.

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1001 ACCESSORIES TO INSURE HIGHEST AIR CIRCUITRY PERFORMANCE

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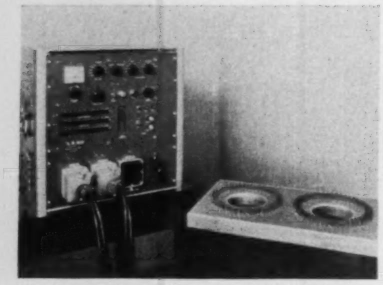

UNIT CAN SEQUENTIALLY TEST 450 ELECTRICAL CABLE CIRCUITS

Model CHA-1001 Hipot tester is cable of sequentially checking up to 450 electrical cable circuits for continuity and high potential leakage resistance. It has adjustable rates from one circuit per minute to 10 circuits per second. Although standard units are designed to test up to 150 circuits, use of Add-A-Unit attachments increases the test capacity in 100 circuit steps up to 450 circuits. Test voltage is stated at 0 to 2100 v dc, while continuity test current is rated at 2 amp at 0.1 ohm. The tester operates from any standard 115 v ac 60 cycle power source. Operational parameters for continuity tests with this device are given as 0.1 ohm to 1000 ohms minimum, and for leakage tests as 1 megohm to 200 megohms minimum. **A. W. Haydon Co.,** 4020 Ince Blvd., Culver City, Calif.

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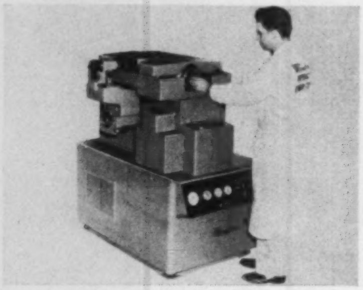

DRILL POINTER SHARPENS UP TO 20 SMALL DRILLS PER MINUTE

Additional accessories for Model 100-A Winslo-Matic drill point grinder include standard type workheads for pointing Type 4 drill points (or other helical, self-centering points), split points, and conventional points on drill sizes from 0.032 through 1.50 inches. Two crankshaft workheads are also available for producing precision crankshaft or split points on 0.093 through 1-inch diameter drills on a production basis. Carbide drills can also be sharpened on a production basis, also special cutters such as two flute end mills, 180-degree bottoming drills, drill points on most drill countersinks, mill cutters, and special end grinds on transfer punches, etc. Indexing is controlled at the point of the drill. Drill angle is formed on a 20-inch diameter grinding wheel. **Winslow Product Engineering Corp.,** 47 St. Joseph St., Arcadia, Calif.

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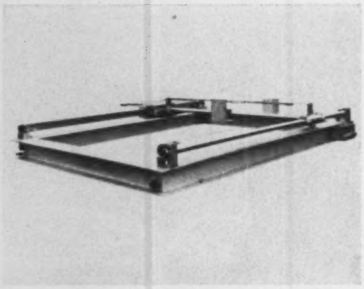
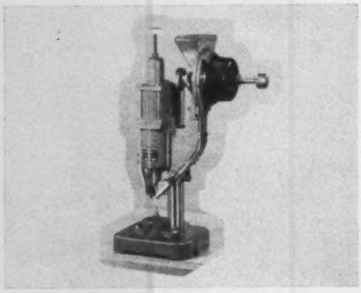


ELECTROLYTIC TANK PROBE SERVO POSITIONING SYSTEM

System may be used to position a probe in an electrolytic tank. Typical use with a tank is under control of an analog computer, to control the position of a probe to measure potentials in the electrolytic bath. Similar to an X-Y recorder, the unit operates from a voltage input to position the head anywhere within a 42 by 58-inch area. The head provides vertical and horizontal mounting surfaces useful for mounting probes or other special devices up to 30 lb in weight. The open frame makes it suitable for placing above a tank. Traverse speeds up to 6 inches per second are obtained with a maximum positioning error of 0.05 inch. Servo amplifiers and power supplies are separate from the main frame and are suitable for rack mounting. **Benson-Lehner Corp.,** 11930 Olympic Blvd., Santa Monica, Calif.

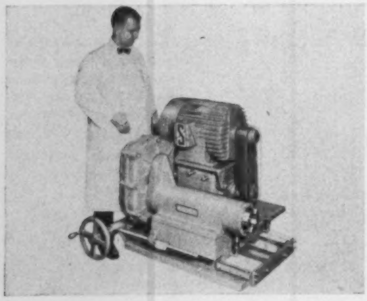
Circle 424 on Page 35



HOPPER FED TUBULAR RIVETER

All electric bench type riveter, designated Model SMR Electrorivet, is specially designed for automatic feeding and setting of tubular rivets and other small fasteners up to ⅛-inch diameter. Typical applications include work on car radio chassis, small speakers, photographic equipment, instruments, switches, etc. Feeding and setting speed is up to 60 per minute. Where careful control of the degree of clinch of the rivet is necessary, a variable transformer (Variac) is available as an accessory, enabling the riveter to operate at any desired impact, from a featherlight tap to its maximum rated capacity of 3500 lb. The range of precision control makes it possible to extend the use of the riveter to applications involving hard to work, brittle materials. **Black & Webster Inc.,** 570 Pleasant St., Watertown 72, Mass.

Circle 425 on Page 35



MILLING SPINDLE AND SLIDE ASSEMBLY

Super precision milling spindle and slide assembly performs the major cutting operation on a special milling machine for milling the curvature in steel mill rolls, while the rolls remain mounted in their respective housings, without dismantling. The rolls are driven and the machining operation is accomplished in one rotation of the roll. Depths of cut vary from a light finish cut to a maximum of approximately 0.125 inch. The rolls are milled in pairs. The 20 hp motorized assembly has seven speed changes from a minimum of 70 rpm to a maximum of 450 rpm. This slide is equipped with a Micrometer dial, gage bars, and vernier scales for setting the milling cutter position. **Standard Electrical Tool Co.,** 2550 River Rd., Cincinnati 4, Ohio.

Circle 426 on Page 35

Millions of picnics in corrugated

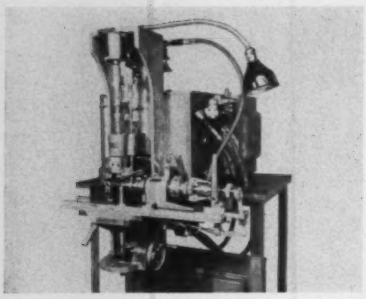
Broil the burgers. Break out the beer. America's picnic basket overflows with good things to eat. Tons of summertime snacks are shipped in corrugated boxes by Hinde & Dauch Division. Sturdy, lightweight boxes—planned for shipping economy. Leading food producers regard H&D as their primary source for money-saving *corrugated boxes in volume.*

West Virginia Pulp and Paper

Hinde & Dauch Division

17 Plants • 42 Sales Offices • Sandusky, Ohio

Circle 689 on Page 35



FUSING MACHINE HANDLES ALL SIZES MOTOR ARMATURES

Machine, developed by Joyal Products Inc., Newark, N. J., is designed for fusing commutators on fractional hp motors. It assures quality jobs through increased brush life and reduced commutator damage. Four models are available, two automatic, one of which has a collet lock and ejector. This machine eliminates the need for black oxide. All models are available with either synchronous tube or mechanical timers. Complete machine comes mounted on a metal table that requires only 5 square feet of space. **Warner Equipment Co.**, 250 McWhorter St., Newark 5, N. J.

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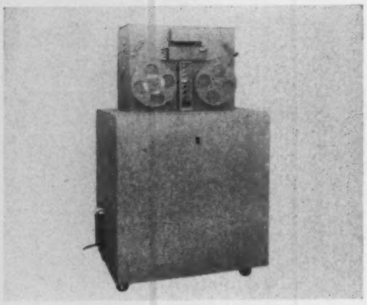

TAPE-TO-CARD CONVERTER HANDLES VARIOUS SIZE TAPES

Solid state tape-to-card converter is basically a block tape reader and decoder. Complete system consists of a Model 55 tape-to-card converter and a standard IBM summary punch. It is capable of converting 100 cards per minute. Block length is 22-44 digits—5 to 8 channels. Unit will handle tape sizes of 11/16, 7/8, or 1 inch. Tape stored on 10-inch diameter reels can be in any code normally used to express numeric data. **Data Instruments Div., Telecomputing Corp.**, 12838 Saticoy St., North Hollywood, Calif.

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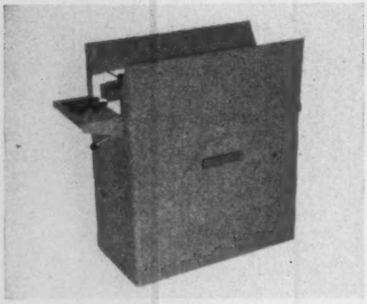

DIP SOLDER MACHINE FOR CIRCUIT BOARD ASSEMBLIES

Circuit board assemblies can now be dip soldered to acceptable military requirements on this Hydro-Dip processing machine. With their leads trimmed and clinched against circuit paths, an assembly is fluxed and presented for dip soldering. This is accomplished by thrusting the board between preset carriage chips and actuating the cycle valve. Board then traverses forward, down into contact with the molten solder, and up again for discharge at the opposite end of the machine. Optional available is provision to bring the soldered board back to the load station of the machine. Machine is hydraulically powered at low operating pressure. Solder pot is 220/440 volt and maintains proper temperature by use of a thermostat. **Associated Circuit Craft**, P. O. Box 1664, Glendale, Calif.

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MACHINE FOR STRIPPING BRAIDED WIRE SHIELDING

Machine has been designed for stripping braided wire shielding from coaxial cable and shielded wire. Potential users include the radio and TV, telephone, wire, and electrical appliance industries, as well as the computer industry. This shielding stripper enables the manufacturer to standardize the length of shielding cut. It is available in two models: Model 15 which can cut shielding lengths from 1/2 to 1 1/2 inches, and Model 35 which cuts lengths from 1/2 to 3 1/4 inches. Lengths are infinitely variable within the limits. Diameter of the shielding accommodated is fixed, but cutting heads for different diameters are available and readily interchanged. **Cadre Industries Corp.**, Box 150, Endicott, N. Y.

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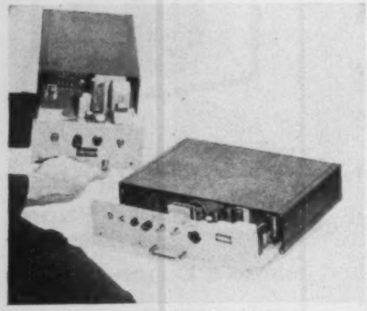

TRANSISTORIZED FREQUENCY TELEMETERING SYSTEM

High-accuracy, all transistor telemetering system can be used by electric utilities to telemeter such quantities as watts, volts, amperes, and vars to a central location from remote sensors. It is readily adaptable to transmission of any quantity that can be converted to a dc millivolt signal. Wide use in oil and gas transmission, and in hydro applications is anticipated. Features include a new package design that cuts rack space requirements, and use of plug-in modular units that contribute to easy maintenance and quick changeover of input, output, and carrier frequency. Basic system has a frequency rating of either 5-15 or 6-27 cycles per second. Receiver is capable of operating a wide variety of indicators, potentiometric recorders, and other end devices. **General Electric Co.**, Schenectady 5, N. Y.

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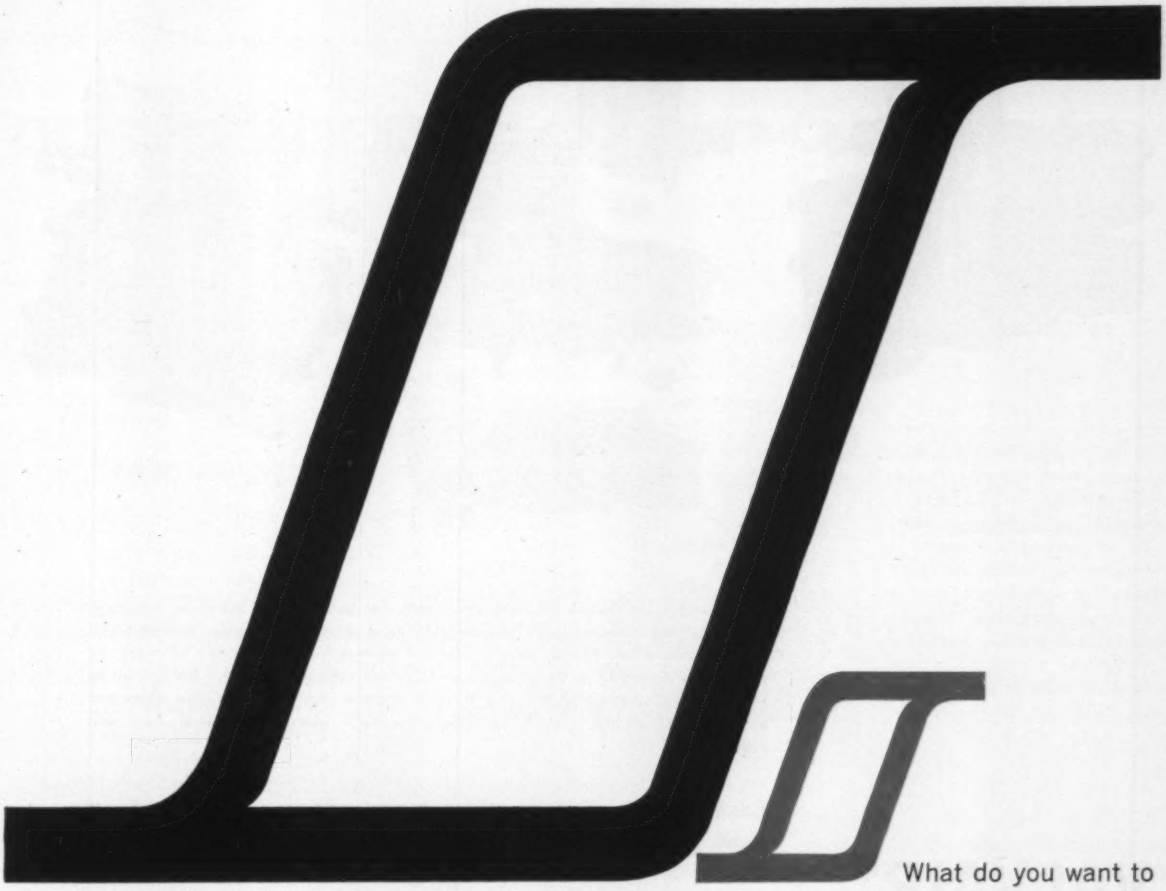
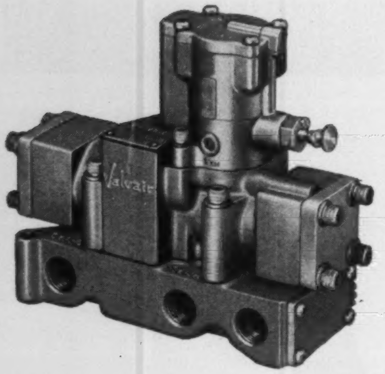
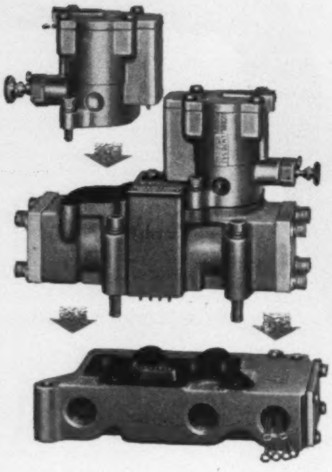


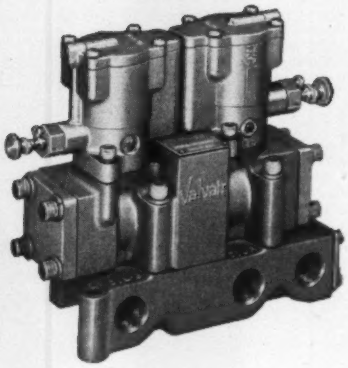
What do you want to control? The flow and measure of 20,000 amperes in an aluminum ore processing plant? (A large static control system will provide pinpoint control—and eliminate the need for direct connections between meter panel and bus bar.) Or do you want to supply exact change in an automatic bill-changer? (A small static control system will do this—and detect counterfeits to boot!) Large system or small, static control can be the answer. ■ We show large and small hysteresis loops to define these systems as *magnetic* static control. Such systems have no moving parts (static), and under normal operating conditions will never burn out or wear out. There is virtually no maintenance needed, almost no heat loss, and fewer components than in conventional systems. Static control systems are used on automobile assembly lines, for annunciator systems, and for controlling the speed of 1/20-hp motors. If you, too, would like to learn what your operating statistics and costs could be by using magnetic static control, write to Magnetics Inc., Dept. **A-87,** Butler, Pa.

INDUSTRIAL CONTROL EQUIPMENT

MAGNETICS inc.®







4-way single or double pilot-operated types, for sub-base or manifold mounting. Aluminum and stainless steel components assure multi-million cycle dependability. Interchangeable pilots, with coils guaranteed against burn-out for life of valve, fit any plug-in Speed King. Coils for AC or DC, most voltages . . . 35 — 200 psi range . . . integral junction box . . . optional manual over-ride, sub-base connected external pilot supply . . . ¾ in. separate exhaust ports, ½ or ¾ in. inlet and cylinder ports.

VALVAIR®
½ in. NPT
PLUG-IN
VALVES

Based on the service-proved design principle of Speed King ¼ in. plug-ins, Valvair's ½-¾ in. plug-in valve series provides plug-in convenience and versatility to a wider range of control valve applications.

Electrical and pneumatic circuits are completed automatically when valve and pilot are plugged in . . . bolted down. The result—cost-cutting reduction of original installation and maintenance time. All power connections are made permanently in sub-base or manifold . . . there's no need to disturb piping or wiring for quick in-service maintenance.

What's more, advanced design shortens stroke . . . speeds response. Separate coded (4-wire) circuits on double solenoid models meet JIC requirements. Flow area through valve and sub-base equals or exceeds that of full ½ in. pipe.

Whether your control valve applications are on the drawing board or now in service, it'll pay you to investigate the advantages of Valvair plug-in design. A call to your nearby Bellows-Valvair field office will bring prompt application engineering recommendations.

For more information, write for Bulletins SPL and DPL. Address Bellows-Valvair, Akron 9, Ohio, Dept. AU-561.

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DIVISION OF INTERNATIONAL BASIC ECONOMY CORPORATION (IBEC)

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AUTOMATION new components

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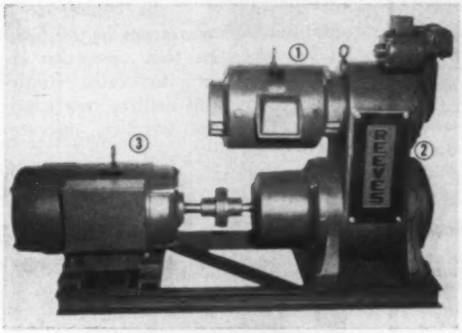
For detailed information and literature, use card page 35.

Variable Frequency Power Supply



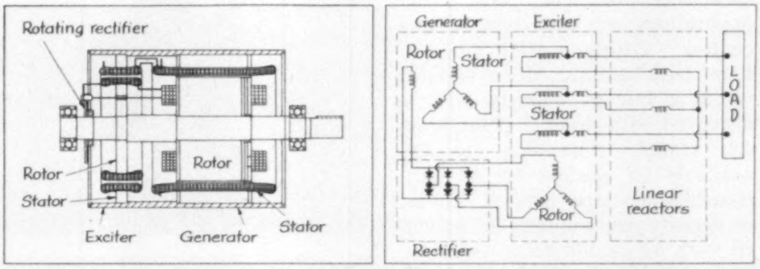
Variable-frequency power supply system consists of (1) speed changer drive motor, (2) manually or remotely controlled speed changer, and (3) ac alternator having an integral dc exciter. Alternator is flange-mounted to speed changer for ratings up to 10 hp output and is foot-mounted on a common bedplate, shown, with a flexible coupling for ratings above 10 hp.

PACKAGED variable-frequency power supply system has been developed by **Reliance Electric & Engineering Co.**, 24701 Euclid Ave., Cleveland 17, Ohio, to provide a means of starting and controlling the speed of multimotor production units. The function of the system, called Vari-Cycle, is to supply a variable frequency output, through a range from 20 to 100 cps, which can be used to vary the speed of one or more ac motors supplied by the system over a 5:1 speed range at a constant-torque output.

The Vari-Cycle system consists of three units integrated into one package. These units are a mechanical speed changer (Reeves Motodrive) driven by either a squirrel-cage or a synchronous-reluctance ac motor and a newly designed brushless ac alternator having an integral dc exciter. By varying the ratio of the speed changer—either manually by handwheel or remotely by a reversing motor and pushbutton station or by pneumatic system—the alternator will increase or decrease in speed and supply variable frequency power to the load motors. For example, a 5-hp, 4-pole ac motor will run at 1800 rpm when the power supply is 60 cps, neglecting slip of motor. By changing the frequency within the range of 20 to 100 cps, the speed of the motor can be varied in an infinite number of steps from 600 to 3000 rpm with capacity varying from 1 2/3 hp to 8½ hp.

The ac alternator is a conventional rotating field synchronous unit with the rotor having a salient pole construction with an amortisseur winding. In addition, the dc exciter is built integrally within the alternator so that the alternator and exciter stators are in a common housing, and the alternator and exciter rotors and a rotating rectifier unit are mounted on a common shaft. The output of the exciter rotor is applied to the alternator field winding through the rotating silicon rectifier unit. All electrical connections between the exciter stator windings and the alternator stator windings are made internally, and only the output power leads of the alternator-exciter unit are brought out to conduit box.

Response time of the integral excitation system is very fast since the exciter carries an alternating voltage proportional to the load current. Any increase in load current causes an immediate increase in ex-



Cross section of alternator is shown in left diagram, and electrical circuit is shown in right view. The generator is a 3-phase unit, and the exciter stator and rotor also have 3-phase windings. A portion of the exciter stator winding is connected across a tap on the alternator stator winding which is a relatively small portion of the alternator output voltage. This exciter shunt winding provides the alternator field excitation power required for no load voltage. Another part of the exciter stator winding is connected in series with the power winding circuit of the alternator and provides a compounding excitation characteristic. The exciter rotor is in effect the secondary of a rotating current transformer induction frequency converter. The exciter rotor output voltage is applied to the alternator field winding by the 3-phase full wave rotating silicon rectifier unit.

AIR CONTROL PROBLEMS ?

PSC

ELIMINATE THOSE PROBLEMS—reduce maintenance and down-time—step-up production and solve the problem of costly repairs and replacement of air tools.

Compact package unit solves all three problems simultaneously.

- Regulates
- Lubricates
- Filters

Easily installed—only 2 connections

AIR EQUIPMENT and tools give top performance when the "working" air stream is
accurately regulated
efficiently lubricated
and free of dirt, grit, scale and water.

REGULATOR

BALANCED PISTON regulator maintains accurate regulation—balances air surges —automatic bleed-off. —long trouble-free service.

FILTER

DUAL FILTERING—CYCLONIC action—clean uncontaminated air—eliminates costly repairs, maintenance and replacement of air tools due to dirty air. Less down-time.

LUBRICATOR

AUTOMATIC FOG MIST lubrication prevents rusting and scoring—reduces costly repairs and replacement of air tools. Won't flood.

PSC complete line of single and combination controls listed in Bulletin 80. Send for copy today.

QUICK DISCONNECTS

The fast, easy operating PSC Disconnects permit quick, economical making and changing set-ups. **Less down-time—more production time.**

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Circle 691 on Page 35

citer output, which is then rectified and applied to the alternator field winding. Fast alternator recovery time, coupled with a plus or minus 5 per cent voltage regulation, allows any combination of motors to be started across the line while other motors supplied by the unit are running. For example, a 7½-hp motor can be started across the line while a 2-hp motor is already running at synchronous speed, and no stall would occur.

Torque-compensation control—necessary when individual motors are driving a chain conveyor—is obtained by a variation of the basic Vari-Cycle. In this case, the exciter stator includes only single-phase power and utilizes two windings. The first winding operates during motor startup and the second winding during normal operation. When the run winding is activated, a series-connected variable-ratio transformer is used to adjust alternator output voltage, permitting torque adjustment and load sharing between motors.

When synchronous - reluctance motors are used in a system and are "locked together" at a precise speed, the problem of starting individual motors is critical while other motors are running. The Vari-Cycle system can start individual motors without overloading the alternator by means of ordinary across the line starters due to its fast recovery time and excellent voltage regulation.

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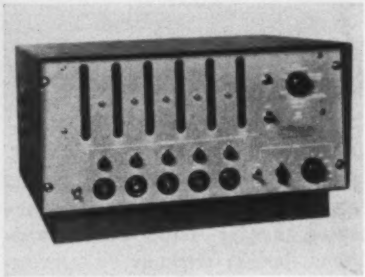

Computer Scaler

All-electronic computer scaler is a true events-per-unit-time computer designed for work involving medium and long time base intervals as encountered in nuclear, electronic, industrial, and other applications in measurement and control. Within a wide range of time base settings the computed counting rate or quotient will be displayed with decimal point properly placed. The data are also available for readout on an associated paper tape printer. Single or repeat-cycle counting is provided with adjustable delay times between cycles to enable visual or paper tape readout. Model QS-6 Read-O-Matic is ideal for all-purpose use in nuclear measurements and for use with automatic sample changers or similar devices. Provision is made for ratio counting in which an unknown count rate may be read out as a per cent of a reference or standard count rate. Input impedance is 1 megohm, sensitivity, 0.25 v minimum signal, and frequency 50 kc. Unit provides output to paper tape printer in 1-2-2-4 binary coded decimal system, output signal to operate external 10k ohm relay, or preamplifier power of 6.2 vac at 5 amp; 250 vdc regulated 15 ma. **Automation Inc.**, 5959 S. Hoover St., Los Angeles 44, Calif.

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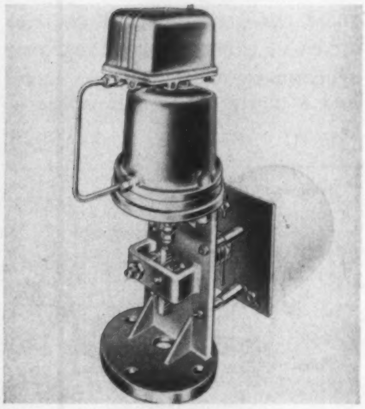

Piston Actuator

Pneumatically operated piston actuator has been combined with a rack and pinion to convert the linear motion of the piston rod to rotary motion. Model 487 actuator then positions a rheostat in response to a pneumatic signal. It produces 185 lb-in. of torque with 40 psig air supply. At full piston rod travel

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Sylvania cuts the price of automation

New, compact 44-station automatic transfer machine brings the benefits of automation within reach of most manufacturers.

It's about half the size of other top-quality transfer machines, far less expensive, too. What's more, it dovetails neatly into the trend to smaller and smaller products and assemblies by providing more stations per foot.

It's a machine that could be ideal for you if you make any product that involves several station-to-station operations.

WHAT IS A TRANSFER MACHINE?

It's automation's basic building block. It moves pieces-in-production from one tool or worker to another, stops the piece long enough so it can be bent, drilled, tapped, heated, measured, molded, riveted, coated, assembled, packaged, etc.

Sylvania makes several models of these basic machines. And if you do not have facilities, we can recommend reliable and experienced manufacturers of the necessary tools, jigs, etc., which you'll need in your automation program.

HOW TO AUTOMATE

That's a tough one. It varies almost with each manufacturing operation. Sylvania will provide free consultation to help with your particular problem but, in any event, there's one basic rule for almost every situation: *You must start with the best transfer machines if you're going to realize the full benefits of automation.*

Naturally, you pay more for the best. But a good transfer machine can last for 30 years or more. What's more, by changing tools and jigs, it can be adapted to almost any conceivable production operation. You can even change products without changing transfer machines.

WHERE TO BUY

Naturally, we're a bit biased, but we believe Sylvania transfer machines are the best on the market.

We've been building them for our own use for over 20 years, because we have never been able to buy one that met our accuracy standards for the manufacture of lamps, tubes, fine electronics equipment.

We make two general types—Rotary indexing chassis and Conveyor indexing chassis. Both have many exclusive features which contribute to their outstanding performance. And we also make 5 models of precision indexing transmissions of superior quality.

FREE HELP—AND INFORMATION. If you're thinking of automating, we'd be glad to have one of our automation sales engineers call on you with his suggestions and advice. Or, if you'd like more details on Sylvania transfer machines, send for our free brochure.

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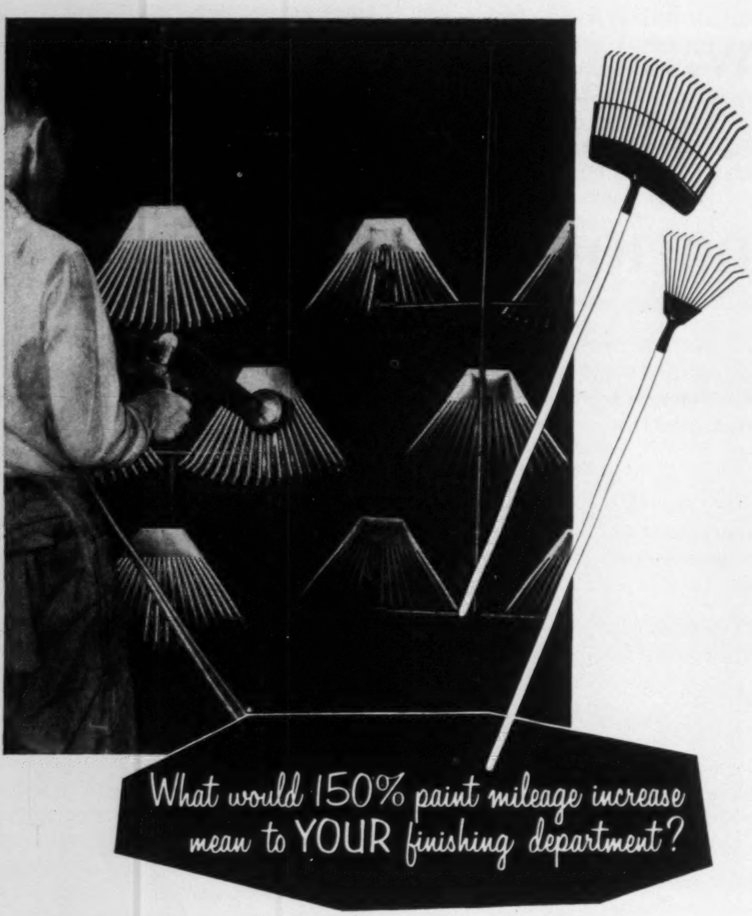
What would 150% paint mileage increase mean to YOUR finishing department?

To Keller Manufacturing Co., Inc., it means a savings of nearly $50 a day in finishing costs on leaf rakes. And, theirs is a comparatively small plant operation.

Before moving into their new plant, this St. Louis manufacturer of Sweep-Easy lawn and garden tools investigated and tried out various finishing equipment. They chose Ransburg No. 2 Process to do the job because they found that only the Ransburg Electrostatic Hand Gun could give them the desirable increase in production—with improved quality—and at lower cost.

PRODUCTION IS NEARLY DOUBLED
QUALITY OF FINISH IS IMPROVED

With the Ransburg Hand Gun, Keller's daily painting prodution of leaf rakes nearly doubled what they were formerly getting with air hand spray. And, where they used to get only 168 rakes per gallon of paint, they now get 426 per gallon—over 2½ times as many—actually *an increase of over 150% in paint mileage.* With the unique "wrap-around" feature, electrostatic is improving the quality, providing a complete, uniform coating over all areas—even on the tine edges.

NO REASON WHY YOU CAN'T DO IT, TOO!

See how the Ransburg Electrostatic Hand Gun can save time . . . paint . . . and cut costs in YOUR finishing department. Or, if your production justifies, it'll pay you to investigate Ransburg's automatic electrostatic spray painting equipment. Write for our No. 2 Process brochure which shows numerous examples of modern production painting in both large and small plants.

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(4 in.) the rheostat is rotated 360 degrees, so that a one-to-one ratio exists between piston rod travel and rheostat rotation. Travel stops are available to arrest rheostat travel at 315, 320, 325, and 330 degrees rotation. **Fisher Governor Co.,** P. O. Box 307, Marshalltown, Iowa.

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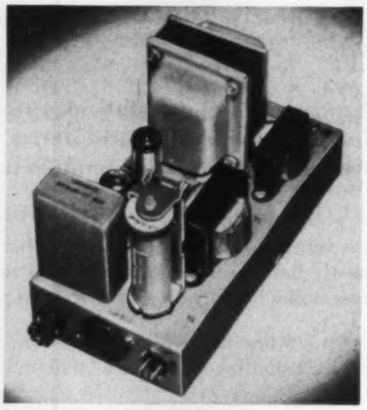

Tone Generator

Tone generating device is telephone engineered to transform dialed pulses from a telephone dial to interrupted tone signals for transmission over any voice channel. With digital decoders at the receiving end, the TGS-720 completes a reliable inband signaling system for station selection or remote control. It consists of a highly stable tone oscillator and a regulated power supply working directly from 117 v, 50-60 cps, ac. Although designed primarily for signaling over wire lines, this tone generator works equally well over carrier, microwave, and radio in any combination. It is ideally suited for selective call systems such as remote dispatcher locations, distant control of microwave repeater stations, remote operation of power equipment, and other applications where trouble-free digital coding systems are required for station or equipment selection. All connections, except ac power, are made to a single 11-pin connector which mates with the input-output connector on the unit's chassis. The ac power core is attached to the 2-pin mating connector which is provided. **Secode Corp.,** 555 Minnesota St., San Francisco 7, Calif.

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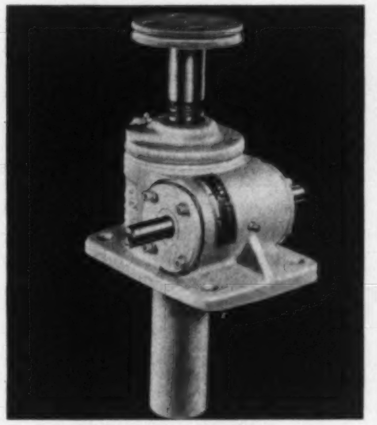

Worm Gear Screw Jacks

Line of worm gear screw jacks has been expanded to include 2-ton and 5-ton capacity jacks in addition to a 215-ton model. Uses of these jacks include vertical adjustment of production machinery and stabilizing of mobile devices. They may be installed in any position for linear actuation of existing equipment or may be designed into original equipment to provide impact resistance and precise leveling or to expedite service and maintenance. The 2-ton model has a worm gear ratio of 6:1, 5-ton jack (shown) is available in 6:1 and 24:1 models, and the 15-ton is supplied with 8:1 and 24:1 ratios. All are available with travel to suit requirements. Drive mechanism has been designed to withstand bidirectional vertical loads. **Joyce-Cridland Co.,** 2027 E. First St., Dayton 3, Ohio.

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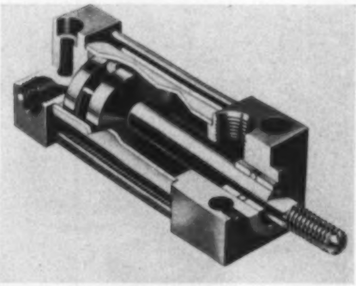
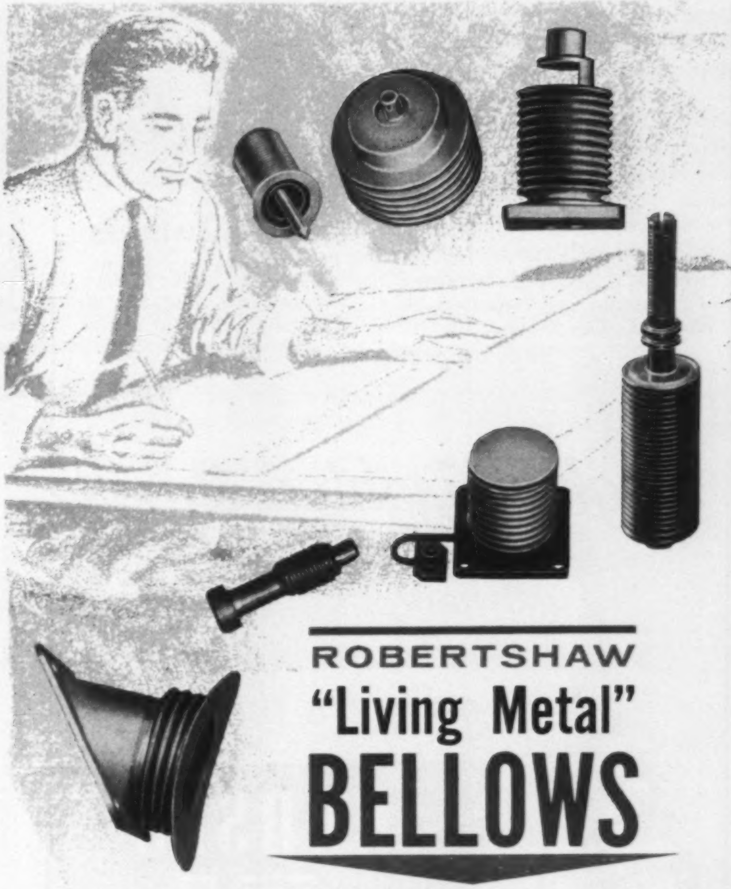


Pneumatic Cylinder

Maximum 200 psi air cylinder is offered in 3/4, 1, and 1 1/8-inch bore sizes with standard strokes ranging to 12 inches in double-acting models. Spring-return models are also available. Square head Series S



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The quote comes from an engineer who's seen it proved again and again . . . where critical requirements demand a flexible connector or expansible tubing that would stand up under extremes of temperature, pressure or atmosphere.

Exceedingly versatile, Robertshaw bellows are custom-engineered to specific needs . . . and are available as complete, pre-tested *bellows assemblies* that save you time, trouble, expense . . . to get your finished product on the road, in the air or into space quicker and at highest efficiency.

Every Robertshaw bellows is backed by the most experienced know-how in the field. We built the first seamless metal bellows; and we're still building the best . . . in inconel, inconel-X, beryllium copper, brass, phospher bronze, monel, stainless steel and Ni-Span-C.

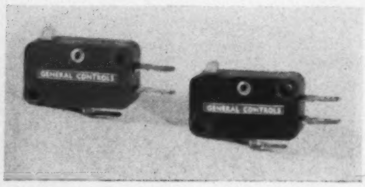
There's a world of information on bellows versatility in our comprehensive Catalog EK-R. Write for it today.

Robertshaw
MR. CONTROLS ®
Robertshaw-Fulton Controls Company
FULTON SYLPHON DIVISION, KNOXVILLE 1, TENNESSEE

Circle 694 on Page 35

Midget-Air is ideal for small force cylinder applications which demand compact size and mounting versatility. Four basic mountings are inherent in the Midget-Air universal design with optional clevis and flange attachments available upon request. O-ring seals assure dependable service at all working pressures. Special seals can be provided if working temperatures exceed 165 F. **Hannifin Co.**, Dept. 142, 501 S. Wolf Rd., Des Plaines, Ill.

Circle 437 on Page 35



Precision Switches

Line of basic small precision switches is ideal for automation switching and limit control devices. Designated as S-8 Klikswitches, they provide on-off snap action in a choice of 8 oz maximum operating force, or standard 7-16 oz operation. Power ratings are up to 10 amps, noninductive, at 125-250 v ac, ½ amp at 125 v dc, and ¼ amp at 250 v dc. Motor ratings at 125 v ac are 6 amps full load and 36 amps with locked rotor. **Automation Controls Div., General Controls Co.**, 8080 McCormick Blvd., Skokie, Ill.

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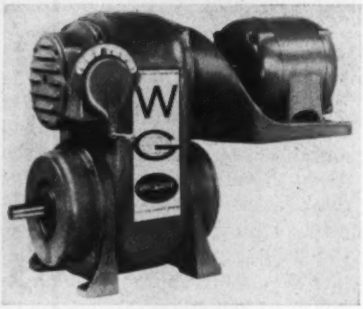

Variable Speed Drives

Line of mechanical variable speed drives is available in three sizes, covering the horsepower range of from 1 to 10 hp with a wide speed range of up to 8 to 1 ratio of speed variation. Vari-Master drives include use of a fan on the variable speed shaft to allow maximum cooling of the belt and longer belt life. A StraitLine gear reducer provides low output speeds. **Industrial Products Div., Western Gear Corp.**, Belmont, Calif.

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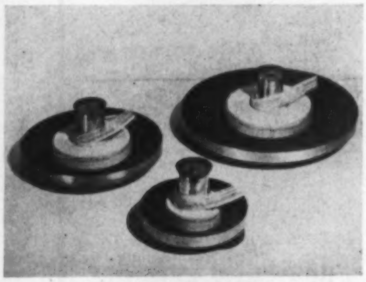

Center Feed Unwinders

These unwinders make it possible to plan consecutive use of punched data tapes without having to rewind. They have been added to a

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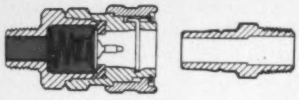

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COUPLINGS

Tougher... Lighter... Smaller

handles more air with minimum pressure drop

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QUICK-CONNECTIVE
RING LOCK
COUPLING

Handles any job in your shop using 3/4″ to 1/8″ connections — from the air line to the air tool — eliminates any need for various size couplings in hook-up — makes it easy to keep stock of parts in balance — holds inventories to a minimum.

All Series 2-RL Sockets and Plugs are completely interchangeable — likewise all larger Series 3-RL Sockets and Plugs.

Has fewer parts. Locking ring provides positive lock...tight fit...minimum wear. Equipped with automatic sleeve lock.

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Instant Automatic Flow or Shut-Off

Quick-Connective Fluid Line Couplings for... COMPRESSED AIR
HYDRAULIC FLUIDS • OIL • GREASE • WATER
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Write for the Hansen Catalog

Here is an always ready reference when you want information on couplings in a hurry. Lists complete range of sizes and types of Hansen One-Way Shut-Off, Two-Way Shut-Off, and Straight-Through Couplings.

SINCE 1915 QUICK-CONNECTIVE FLUID LINE COUPLINGS
THE HANSEN MANUFACTURING COMPANY
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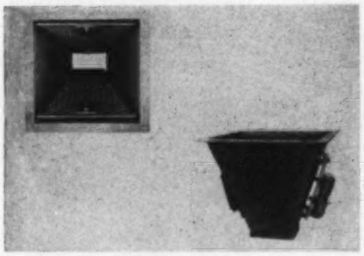
Circle 695 on Page 35

line of tape-file data processing accessories and are available in 6, 9, and 12-inch diameters. Applications include use on all transmitting equipment and on tape-to-card units. **Dresser Products Inc.**, P. O. Box 2035, Providence 5, R. I.

Circle 440 on Page 35



Bridge Breaker

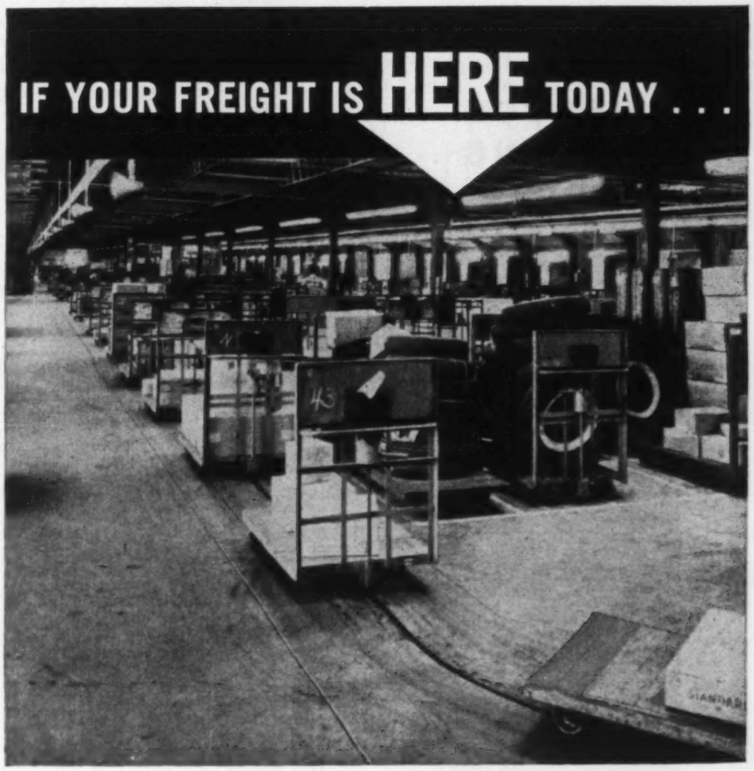
Designed to move hard to handle materials which have a tendency to bridge, cake, and otherwise obstruct continuous flow through supply bins, Series BB bridge breaker employs rapidly vibrating, expanded metal screens mounted inside the bin parallel to the walls. The screen sections are adaptable to either flat or conical surfaces and are specifically designed for individual applications. They are available for areas up to four square feet, depending on the type of material and bin configuration. **Thayer Scale Corp.**, Thayer Park, Pembroke, Mass.

Circle 441 on Page 35

Inverted Spindles

Adjustable inverted countersinking spindles have been developed to increase flexibility of a line of dial type machines. They are designed for countersinking and chamfering operations and are adjusted in the same way as a cut-

IF YOUR FREIGHT IS **HERE** TODAY . . .



Photo, Courtesy of Lyons Transportation Company

. . . IT WILL BE **THERE** TOMORROW

150 CARGO CARRIERS ARE LOADED AND UNLOADED EVERY DAY IN THIS MODERN TERMINAL

It is accomplished with the aid of a Mathews-built Tow Conveyer System pulling floor trucks around a 420-foot, 70-door bay area at 140 feet per minute. The continuous chain conveyer, contained entirely below the level of the floor, provides a smooth flow of freight to and from cargo carriers without delay, confusion, or costly rehandling.

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MATHEWS

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Circle 696 on Page 35

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REDUCE
TESTING
COSTS

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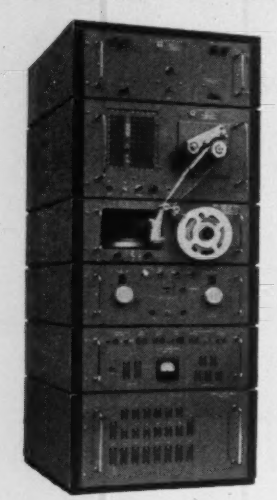
SUPERTESTER®



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Why does the CTI Supertester lead the field? Because this equipment will save 90% of your testing costs. Its outstanding features have made CTI testing equipment sought by the nation's leading industries: high accuracy go/no-go bridge measurements, the widest scope of tests and auxiliary operations, and complete customer confidence gained through fail-safe circuitry and self-testing ability. Automate your electronic testing operations. The CTI Tape-Programmed Supertesters, Models 180 or 210 can strengthen your testing practices and improve your competitive position.

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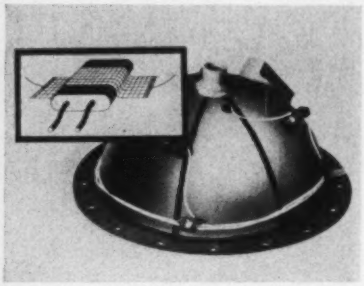
Circle 697 on Page 35

ting tool in a lathe tool post. Spindles are cartridge powered by flexible shaft drives. Depth of cut is set by a micrometer adjusting screw. Device is able to reach any positon of the indexing dial. Ease of adjustment make spindles ideal for small runs of stamping requiring secondary operations such as drilling, reaming, tapping, and chamfering operations on both sides of a workpiece. **Bodine Corp.**, 317 Mountain Grove St., Bridgeport 5, Conn.

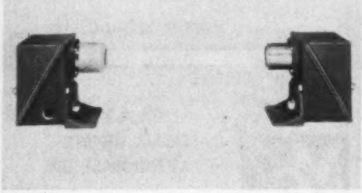
Circle 442 on Page 35



Thermostat Anticipator

Device is now being used on high watt density heating elements where accurate and instant temperature control is imperative. It is enveloped by the heating element itself. This design causes the thermostat to operate at the same temperature as the heating element during the transient and allows the thermostat to be either in series with the heating element or, where the heater's current would exceed the capacity of the thermostat, it can be in series with the field of a relay. **Electrofilm Inc.**, 7116 Laurel Canyon Blvd., North Hollywood, Calif.

Circle 443 on Page 35



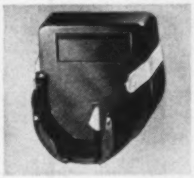
Photoelectric Cell

Invisible surveillance of buildings, objects, grounds, and other areas is provided by this infrared light ac-

NEW
STROMBERG-CARLSON
TELEPHONE
HANDSET
CRADLE

... for positive retention in all mobile applications

There's no jump, no sway—when a telephone handset is in the firm grip of this new Stromberg-Carlson® handset cradle.



Retaining clip spring assembly assures positive retention in any mobile application on land or sea, or in the air. Even extremely severe jars, jolts and vibrations fail to dislodge the handset.

The cradle is strong and resilient, fits any Stromberg-Carlson handset. Different models provide varying switch combinations with 2 or 4 Form C contacts. All models available with or without the clip assembly.

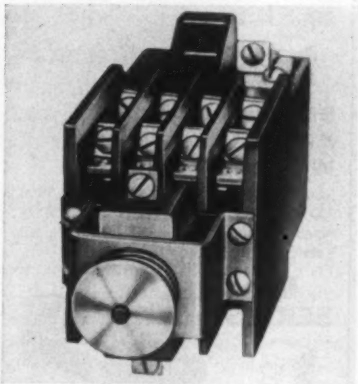
Details on request from these Stromberg-Carlson offices: Atlanta—750 Ponce de Leon Place N.E.; Chicago—564 W. Adams Street; Kansas City (Mo.)—2017 Grand Avenue; Rochester—1040 University Avenue; San Francisco—1805 Rollins Road.

STROMBERG-CARLSON
A PRODUCT OF
GENERAL DYNAMICS | ELECTRONICS

Circle 698 on Page 35

tuated photoelectric control. Each installation requires a photoelectric control designed for actuation by infrared light and a light source with filter to produce the infrared light beam. The control may be used to operate or trigger an alarm, warning system, or other electrically controlled equipment. The lens of the control is shielded from normal light so that operation continues day or night whether lights are on or off. One of the controls is designed for operation at distances up to 100 feet between the light source and the control; operation is from 115/230 v, 50-60 cycles. Another control is designed for distances up to 30 feet between light source and control. This model operates from 115 v, 50-60 cycles. **Autotron Inc.,** Box 722RR, Danville, Ill.

Circle 444 on Page 35

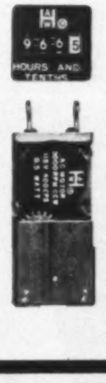


Control Relay

Device is rated at 6 amps, 300 v maximum. It is a fixed circuit unit with provisions for 8 independent poles. Designated as the Compact 300, the relay is also available in 2, 3, 4, or 6 poles in any combination of normally open or closed contacts. Only $5\frac{1}{2}$ square inches of panel space are required for a relay of from 2 to 8 poles and up to 48 poles can be mounted per linear foot. Bifurcated contacts provide four current paths. An electromechanical memory latch can be added to the relay at any time for greater flexibility in control circuitry, particularly when control is needed to match machine sequence. Working as a single unit, latch and relay have continuous duty holding and

PLEASE DON'T SWALLOW OUR MOTOR

...IT'S HIDING BEHIND THE ASPIRIN. Actually, we set out to build an easy-to-read tiny timer...but we first had to build an aspirin-sized motor to drive it. This assignment might have been a headache for a sorcerer, but A. W. Haydon did it. And there is something magical about these microminiature elapsed time indicators and companion events counters. ■ This digital elapsed time indicator has many outstanding features: size is only ½" square x 1 1/16" long...weight .75 ounce...



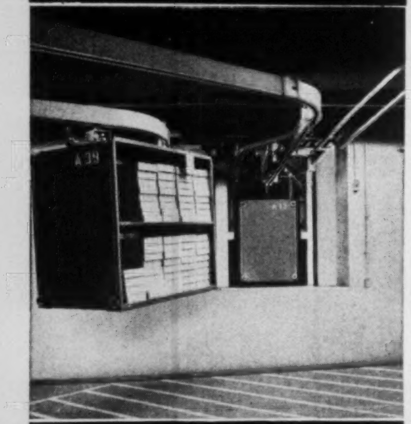
meets all mil specs...temp. range −54 to +125°C...vibration to 2000 cps at 20 G...choice of two ranges (hours to 9999, tenths to 999.9)...power input .5 watt, max. In fact, the complete data outweighs the equipment. Send for our heavyweight literature on the 19200 ETI right now. ■ Electrical or electronic, the A. W. Haydon Company works wonders in time. For electronic requirements call Culver City. For electromechanical devices call on our wizards in Waterbury.

THE AW HAYDON COMPANY
269 NORTH ELM STREET, WATERBURY 20, CONNECTICUT

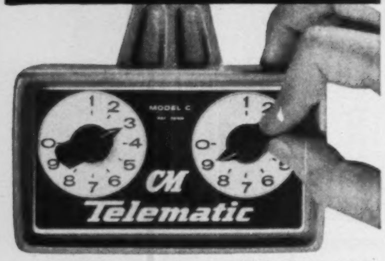
Circle 699 on Page 35

Power -Flex®

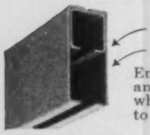
POWER AND FREE OVERHEAD CONVEYOR SYSTEM*



WITH TELEMATIC AUTOMATIC DISPATCH CONTROL



• Simply set dials and Telematic guides carrier to any station in system



Employs exclusive unitized "over and under" power and free rail which permits simple switching to right or left as desired.

Power-Flex is designed for automated materials forwarding applications in industrial plants, distribution centers, service buildings and department stores. The most economical system available for loads up to 600 lbs. per carrier. Savings in actual installations range from 25% to 60%.

*Systems in service for your inspection.

Engineered to your very specific requirements.

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Inquiries from your engineers or consultants welcomed.

CM
Power-Flex system

CM® CONVEYORS

COLUMBUS McKINNON CORPORATION
Conveyor Division
TONAWANDA, N. Y.

Circle 700 on Page 35

release coils permitting complete freedom in control circuit work. **Cutler-Hammer,** 378 N. 12th St., Milwaukee, Wis.

Circle 445 on Page 35

TRIMMERS
LUMEN, INC.
JOLIET, ILL.

Magnetic Amplifier

Low level dc amplifier is designed as an operational amplifier for use in circuits involving sensitive thermocouples or other sensor devices producing very low signal outputs. It incorporates an adjustable network for adaptation to a range of sensor voltages and impedances. For all sensors, output of Model 1201 is 0-5.0 v dc. Specifications: Output impedance, 1000 ohms (maximum); output linearity, ±1 per cent of full scale (±50 mv); excitation voltage, 28 v dc ±5 per cent; frequency response, approximately 2 cycles per second. **Lumen Inc.,** Moen Avenue, P. O. Box 905, Joliet, Ill.

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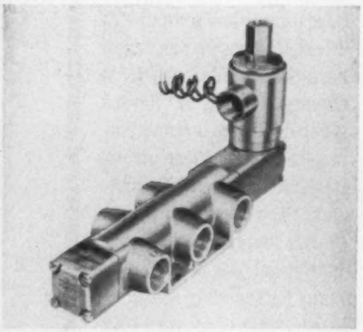
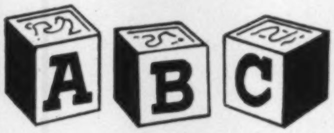


Solenoid Valves

Efficient operation of pneumatic and hydraulic fluid control systems under hazardous environmental conditions can be obtained by us-

How to use FLUID POWER

✓ **efficiently**
✓ **economically**
is as easy as . . .



when you specify

PROVEN QUALITY SP CYLINDERS · BOOSTERS

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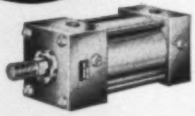

Standard Cylinders AIR or OIL Without Modification

Save money with S-P's complete line; rated 200 psi air, 500 psi oil or water; 23 mounting types; 11 bore sizes—1½" thru 14"; see Catalog 110C.

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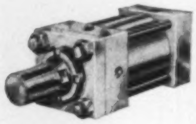
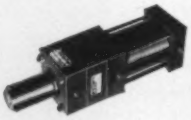


HIGH PRESSURE Hydraulic Cylinders

Get smoother, more precise power; ruggedly built, interchangeable; 2000 psi (3000 psi non-shock); 12 bore sizes—1⅛" thru 12"; get Catalog 117.

SERIES C



Air-Oil BOOSTERS

Save money, save space; boost 80 psi line air to 3000 psi hydraulic power with no added power consumption, no maintenance; see Catalog 116.

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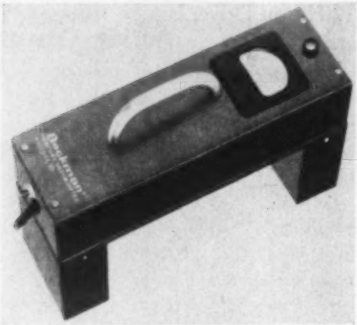
A-2883A

The S-P Manufacturing Corp.
A BASSETT COMPANY
30201 Aurora Road • Cleveland 39, Ohio

Circle 701 on Page 35

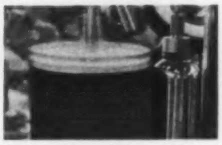
ing this line of explosion-proof solenoid valves. Valves are completely enclosed in a forged bronze body and are available in explosion-proof, dust-proof, water-proof, and fungus-proof constructions. Maximum flow-passage capacity in slim-design sizes from $1/8$ inch NPT through $1/2$ inch NPT in 2, 3, 4, and 5-way types make them ideal for close-quarter installations. They operate on pressures from partial vacuum to 500 psig: UL approved, 110 v 60C coils are standard and others are available. **Versa Products Co. Inc.**, 150 Coolidge Ave., Englewood, N. J.

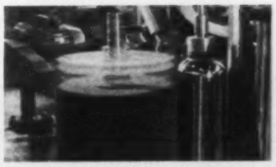
Circle 447 on Page 35

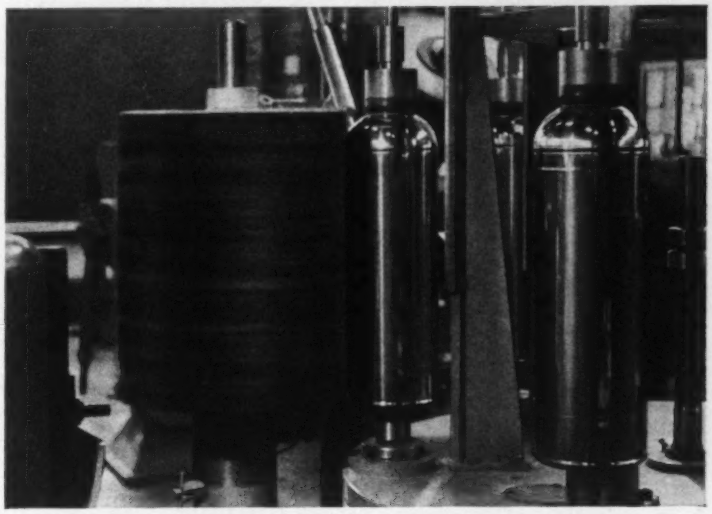


Mercury Vapor Meters

Instruments are designed to provide instantaneous, direct readings of the toxicity levels of mercury vapor in enclosed areas. Industrial and laboratory environments where the meters assure safe working conditions include chlorine and caustic plants, chemical laboratories, wind tunnels, mines, university laboratories, hospitals, and plants where neon signs, dry batteries, or thermometers are manufactured. Three models are available. Model 21 is a single-range analyzer operating from 0.03 to 3 mg mercury vapor per cubic meter. Toxic limit (0.1 mg per cubic meter) is a 10 per cent deflection of the meter. Model 23 is a dual range instrument which is designed to locate areas where low vapor concentrations are being generated. Its ranges are 0.005 to 0.1 mg/cu meter and 0.03 to 3 mg/cu meter. Model 24, also a dual range instrument, features an audio alarm which sounds in the area being checked if the vapor concentration reaches toxic strength. This unit provides unattended monitoring of areas in which va-







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Ever see an Acme automatic polishing and buffing machine in action? If not, you ought to—the sooner the better. It's bound to give you some new ideas about the versatility of mechanical movements and motions. Progressive ideas, too, about how they can be applied to do more work—better and faster—in finishing every conceivable type of part. Large or small—simple or complex. Drawn, spun, extruded—die-cast, forged or machined. Yes, you name it and Acme engineers will quickly demonstrate the kind of action required to improve quality and reduce your finishing costs. Why not send samples of your "problem" parts today for analysis and recommendations? No cost, no obligation.

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Semi-Automatics   Rotary Automatics   Straight Line Automatics   Flat Polishers

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Leading Producers of Automatic Polishing, Buffing and Deburring Machines Since 1910

Circle 702 on Page 35

por generation is possible. **Beckman Scientific and Process Instruments Div., Beckman Instruments Inc.,** Technical Information Dept., 2500 Fullerton Rd., Fullerton, Calif.

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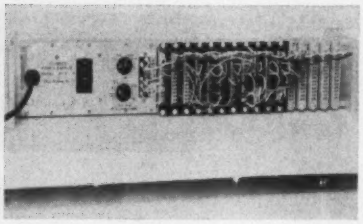

Digital Modules

Series 200 Logibloc transistorized module building blocks are made of a series of few major all-purpose modular plug-in units. They include flip-flops, *Nor* circuits, one-shot multivibrators, gates, drivers for indicators or electromechanical devices, etc. They are designed in such a way that the input and output characteristics of most frequently used units are almost identical. Each modular unit can perform many functions by using different connections on the socket. Each unit is supplied with matching sockets that have low contact resistance even after repeated insertions. Modules are rated to operate at 200 kc/s, although some may operate at 400 kc/s or higher. Only two voltages are needed, −12 v and +6 v. Special units can be provided to connect with nonstandard external equipment such as electromechanical devices, analog voltage switches, etc. Modules are designed to operate within temperature ranges of −10 to +55 C. **Wang Laboratories Inc.,** 12 Huron Drive, Natick, Mass.

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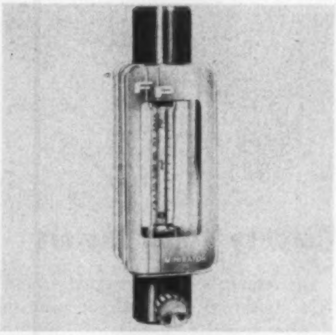

Miniature Flowmeter

Designed for the measurement of low flow rates of either liquids or gases, miniature flowmeter is ideal for analytical applications in addition to normal process uses. Unit, designated Minirator is available with 1½ or 4 inch scales, with or without an integral needle valve, and with the option of brass or stainless steel end fittings. Interchangeability of standard parts for varying capacities is possible. The tube of the flowmeter is of the snap-in type, which permits a change in range in a few seconds, without the use of tools. End fittings can be rotated through a full 360 degrees for ease in mounting, and the meter is designed so that it may be surface or flush mounted on a panel or installed in-line. **Fischer & Porter Co.,** 551 Jacksonville Rd., Warminster, Pa.

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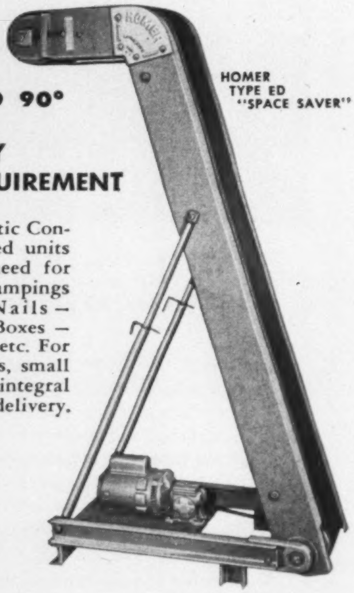


HOMER

"SPACE SAVER" MAGNETIC CONVEYORS

- SPEED UP PRODUCTION
- SAVE FLOOR SPACE
- CUT LABOR COSTS
- CONVEY AT ANGLES TO 90°

A TYPE AND SIZE FOR EVERY MAGNETIC CONVEYING REQUIREMENT

There are Homer "Space Saver" Magnetic Conveyors in standard and custom-designed units to meet practically every conveying need for ferrous metal parts such as Blanks — Stampings — Nuts — Bolts — Rods — Gears — Nails — Washers — Can and Jar Lids — Steel Boxes — Bottle Caps — Machined Parts — Scrap, etc. For original equipment press manufacturers, small delivery conveyors can be furnished as integral parts to be built into presses for parts delivery.

Models ED and MCS "Space Saver" Conveyors are available in standard lengths and belt widths. Custom series models have length, belt width, magnetic strength, and material flow pattern specially designed to fit specific applications.

Homer's "Job Analysis" service studies your requirements and recommends the proper "Space Saver" Magnetic Conveyors for your needs.

Here's how to obtain complete details Fast! Clip this ad—attach it to your letterhead, include your name, title and department and mail to Homer Manufacturing Division. Bulletins describing Homer Magnetic Conveyors will be sent by return mail.

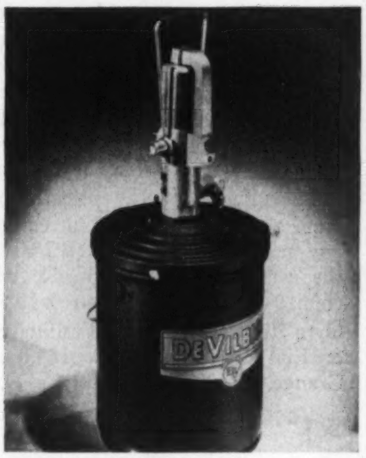
HOMER MANUFACTURING DIVISION

THE OHIO ELECTRIC MANUFACTURING CO.
DEPT. 286 • LIMA, OHIO

Homer

FIRST IN INDUSTRIAL
PERMANENT MAGNETIC CONVEYORS

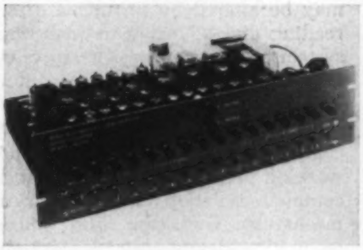
Circle 703 on Page 35



Airless Pump

Seventeen pound, five-gallon capacity pump is particularly suitable for contract maintenance work, for industrial maintenance, and for product finishing. It consists of lid, 5-gallon material container, and handle. This 26-1 ratio pump will handle all conventional paints, using a standard airless gun fitted with medium production caps, and will operate with air pressure produced by a 1-hp compressor. Accessories include regulator assembly with gage and blow gun, material strainer, and swivel connection between the fluid hose and gun for greater flexibility in spraying. **DeVilbiss Co.**, Toledo 1, Ohio.

Circle 451 on Page 35



Electronic Batch Counter

Unit, built into standard electrical cabinet, has been designed to lengthen life of register systems now in use. Normal life expectancy is approximately a billion operations. Counter makes simple preset count, according to specifications and requirements. Four models are available: DC-30 divides the counts by ten, reducing wear on register, either electrical or mechanical. Connecting

One word explains the popularity of these switches...

Dependability!

Denison LOXSWITCH Limit Switches operate with the dependability of Old Faithful. Oil- and dust-tight features, superior electrical characteristics and mechanical design result in three to five times longer life than comparable switches.

DENISON
LOXSWITCH
600 VOLTS MAX

L100W HEAVY DUTY LIMIT SWITCH

- **45 CIRCUIT ARRANGEMENTS.**
- **LONGEST CONTACT LIFE due to lowest impact of 2.5 grams and minimum "bounce".**
- **WATER-, DUST- AND OIL-TIGHT, NEMA 12.**
- **ONLY FOUR MOVING PARTS. Longer life, easier to maintain.**
- **70° SAFETY OVERTRAVEL without use of extra springs or cams.**
- **OVER 150 LEVER STYLES.**

MODEL M PRECISION LIMIT SWITCH

- **LONG MECHANICAL LIFE nylon latch mechanism.**
- **600 VOLT INDUSTRIAL CONTROL RATING.**
- **COMPLETELY ISOLATED CIRCUITS.**
- **6° TRIP DIFFERENTIAL, 50° overtravel in both directions.**
- **PRECISION REPEATABILITY ± .001".**
- **WATER-, OIL-, DUST-TIGHT — NEMA 12.**
- **FULLY INTERCHANGEABLE with thousands of existing layouts.**

DENISON
LOXSWITCH
600 VOLTS MAX

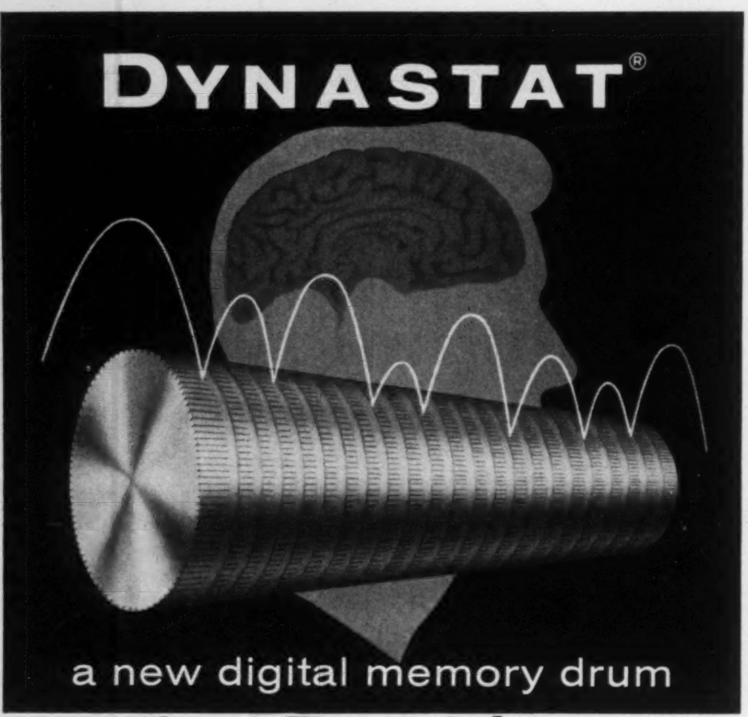
BOTH MODELS AVAILABLE WITH PLUG-IN CONVENIENCE

Write for literature describing our complete line.
Address R. B. DENISON MFG. CO., 386 Broadway, Bedford, Ohio

DENISON LOXSWITCH®

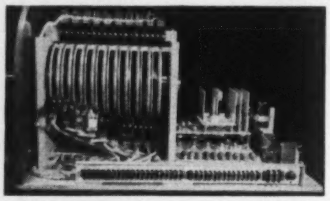
*Wire with **LOXSWITCH** and you wire for good!*

Circle 704 on Page 35


DYNASTAT®
a new digital memory drum

that Provides:

- *INDEPENDENCE OF SPEED (can be read out while standing still)*
- *HIGH LEVEL OUTPUT (no low level signal amplifiers)*
- *CONTINUOUS ACCESS (eliminates buffer storage)*
- *NON-DESTRUCTIVE READOUT (no recirculating delay lines or registers)*



®The DYNASTAT drum operating principle is protected by various patents, both issued and pending.

Here is a digital magnetic memory drum whose read heads respond to flux intensity rather than rate of change of flux.

Because it is independent of rotational speed, the DYNASTAT drum offers new system possibilities in such applications as the programming of machine tools and automation equipment, master control of inspection, counting, conveying, and material handling, and synchronous parallel-to-serial reversible code conversion.

Outstanding reliability stems from the unique bistable action of the read heads which permit a broad tolerance of spacing from the drum surfaces and which offer output levels that eliminate the need for signal amplification.

Many system designs show important economies when the DYNASTAT drum is introduced. Find out how you can profit from the use of DYNASTAT. For complete product information and its application to your need, write or telephone Mr. Charles M. Colt, Bethel, Conn. Pioneer 3-6721, DDD Code 203.

CONSOLIDATED CONTROLS CORPORATION

A Member of The Condec Group

BETHEL, CONNECTICUT
INGLEWOOD, CALIFORNIA

Circle 705 on Page 35

this model in 2, 3, or 4-unit series will increase the division from 10 to 100, or 10 to 1000; BC-40 counts a preset number from 2-16, tripping a relay switch which actuates any electrically controlled function, and then automatically resets to zero for the next count; BG-50, basically the same unit as the BC-40, but counts any number from 2-256: BC-60 is the same unit as the BC-40, but counts any number from 2-1024. **Gyra Electronics Corp.,** Washington & Elm St., P. O. Box 184, La Grange, Ill.

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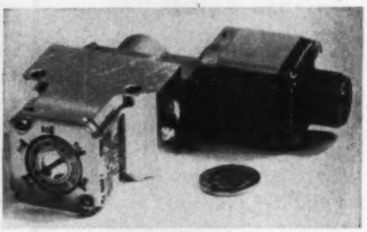


Pressure Switches

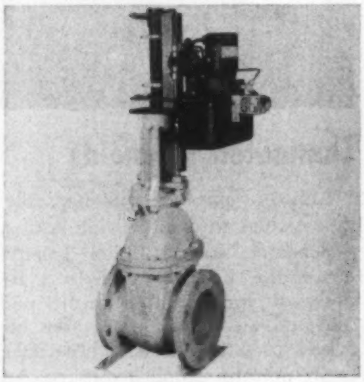
Adjustable Deltadyne pressure and differential pressure switches provide reliable indication over a range from 15 to 200 psig. They open or close an electrical circuit when pressure, differential pressure, or flow becomes too high or too low. Within the pressure range of a given switch, actuation pressure may be altered by turning a direct reading dial. Units can withstand system pressures or overpressures up to 5000 psi. When used as differential pressure switches, they exhibit actuation pressures which are completely independent of absolute working pressure. Features include complete isolation of the electrical mechanism from the fluid and a, magnetic detent which insures against dither when the switch is vibrated near its actuating point. They can be used in all types of fluid lines including pneumatic systems and compressed gas lines, hydraulic systems, process streams, and other types of fluid systems where an alarm device is required. Similar units are available with actuation pressures from 0.25 inch wc to 15 psi, and on special order from 200 to 5000 psi. **Pall Corp.,** 30 Sea Cliff Ave., Glen Cove, N. Y.

Circle 453 on Page 35

Synchro-Verifier Relay

Synchro-verifier relay (Type CVE) is used to verify the condition of synchronism existing between two system voltages. It is adjustable to provide a contact closing zone between plus and minus 20 and 60-degree phase angle difference between the two sources. Relay is connected to two single-phase voltage sources on either side of an open circuit breaker. When these two sources are in synchronism and equal in voltage, the relay contacts close to permit closing the circuit breaker to connect the sources together. Features of the unit include lower volt-ampere burden, minimum magnetic coupling between the two voltage supply sources, and independent electrical circuits for the two sources. **Westinghouse Electric Corp.**, P. O. Box 2099, Pittsburgh 30, Pa.

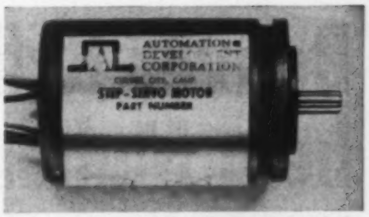
Circle 454 on Page 35



Hydraulic Valve Actuator

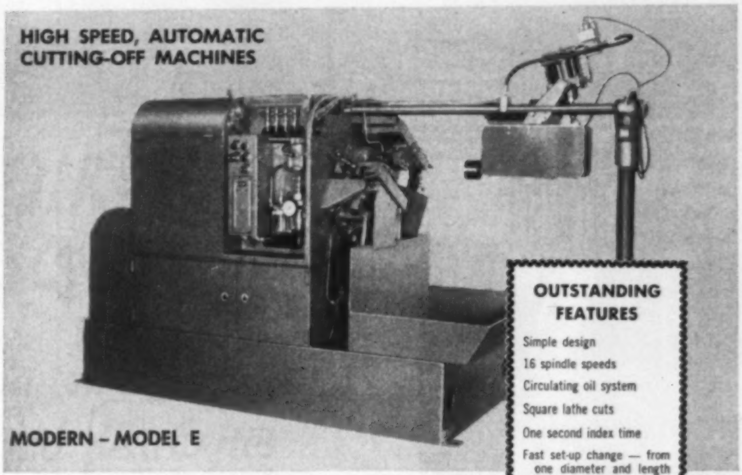
This hydraulic valve actuator on which motor and pump run only for the few seconds required to open or close the valve, and which provides an automatic locking feature that holds gate or plug in any desired position almost indefinitely is suitable for use on virtually any type or size of valve. A complete unit includes a motor, pump and coupling, integral reservoir, pressure switch, and hand pump, gages, and any required safety devices. It can be set up for direct or remote control, permitting single location control of several valves located at different points. **Oil-Dyne Inc.**, 2115C W. Marquette Rd., Chicago 36, Ill.

Circle 455 on Page 35



Step-Servo Components

Line of digital servomechanism components for automatic control applications include a pulse-operat-



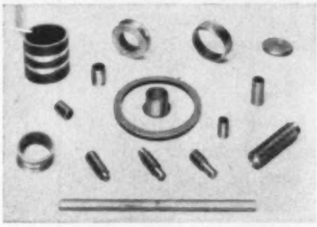
Increase production, lower costs and cut any material that can be turned — bar stock up to 3" O. D. — tubing up to 8" O. D., to lengths from a fraction of an inch to several feet, with micrometer accuracy. Ideal for use with carbide tools.

We also engineer and build machines — using the same bodies and spindles — for such operations as trimming ends of drawn shells and filler caps. Send prints for quotes.

OUTSTANDING FEATURES

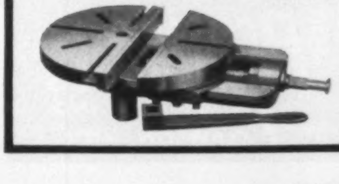
- Simple design
- 16 spindle speeds
- Circulating oil system
- Square lathe cuts
- One second index time
- Fast set-up change — from one diameter and length to another. Any tool can be changed without disturbing others.
- All cams, adjustments and working parts for cross slide are outside for quick, easy adjustment.
- Chip pan slides out, for easy dumping.
- Power, speed and rigidity for cast alloy and carbide blades.
- Special spindle bearing takes all collet thrust. No thrust on main taper roller spindle bearings.

Catalog and production figures mailed on request.



We can furnish special tooling to meet your requirements — to cut-off, form, groove, flange and chamfer in a single operation, at a high rate of speed. Send prints.

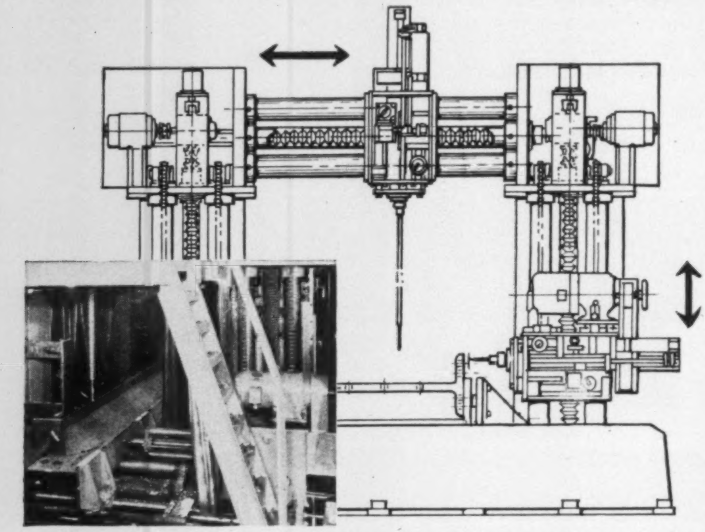
MODERN MACHINE TOOL COMPANY
2005 Losey Street • Jackson, Michigan



FREE TRIAL OFFER. Safe, positive, fast set-ups. The Modern Safety Drill Table handles odd, irregular shapes without V-blocks, clamps or parallels. Ideal for maintenance work. Guaranteed to save its cost in labor alone every 6 months. Sizes from 8" to 27½" dia. Try it at our expense. No obligation.

Circle 706 on Page 35

Beaver Ball Screws help Mahon save 85% in drilling holes in bridge beams, columns

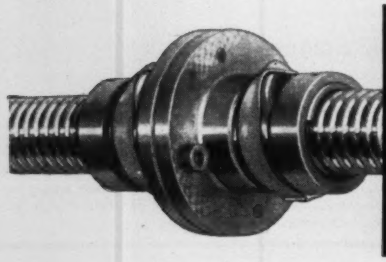


Close tolerance positioning of massive 1½″ capacity vertical and horizontal drill heads is accomplished with Beaver ground-thread ball screws in this new, numerically controlled drilling machine, first in the structural steel industry.

Walter P. Hill, Inc., designed and built the machine
for The R. C. Mahon Co., Structural Steel Division

In addition to the important drilling cost savings, it offers repeatability in hole pattern accuracy within ±.005″ as compared with ±⅛″ by conventional methods and eliminates costly hole reaming in final assembly.

If you are considering data control, Beaver ball screws will give you the power efficiency, positioning control and compactness you need. Our engineers will be glad to work with you just as they did, in this case, with the Walter P. Hill designers.



Beaver Precision Products INC.
CLAWSON, MICH.

Circle 707 on Page 35

ed series of step-servo motors (illustrated) and companion transistorized controllers, a pulse generator, and a dc power supply. Designed to solve many automatic control problems both in industrial and military applications, the controllers and motors can be used either as analog-to-digital converters or digital-to-analog converters. Pulse data can be converted into shaft rotation with sufficient torque and accuracy to drive and position almost any indicating instrument or transducer with great precision. Reversible step-servo motors operate bidirectionally on dc voltages, switched by a logical controller at a desired stepping rate. Industrial applications for these units include batch counting, process controls, and accurate positioning and actuating of machine tools. **Automation Development Corp.**, Culver City, Calif.

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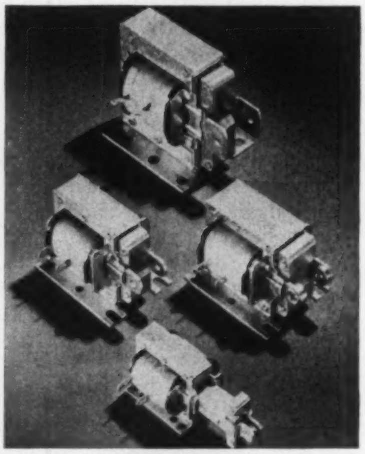
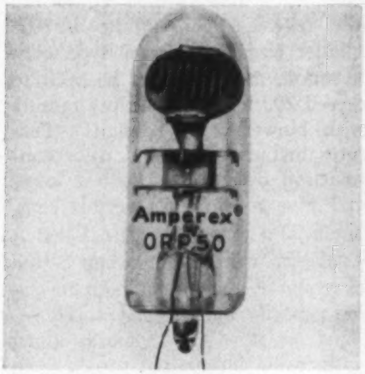


Laminated Solenoids

Line of Super-T laminated solenoids is designed to provide lasting, dependable service under adverse conditions. Features include a redesigned plunger with a sturdier pull bar and a larger contact area between co-acting parts. These solenoids may be supplied moisture resistant, moisture proofed, or with coils completely encapsulated in epoxy resin for varying degrees of protection against humidity, water or oil spillage, or physical damage. Three sizes are available, Models 1000, 2000, and 3000. They are all ideal for use in business and commercial machines, automation equipment, vending machines, and small machine tools. **Dormeyer Industries,** Dept. An-5, 3418 N. Milwaukee Ave., Chicago 41, Ill.

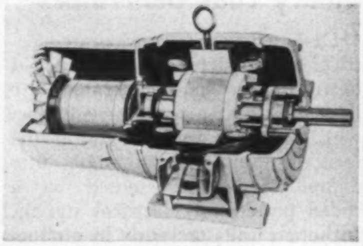
Circle 457 on Page 35



Cadmium Sulphide Cell

Light-sensitive cadmium sulphide cell, ORP 50, is both top and side sensitive. This double sensitivity was accomplished by positioning the cadmium sulphide area at a 45-degree angle. Being hermetically sealed and of rugged all-glass construction, this cell can be used for such industrial uses as flame control, on-off switching, relays, automatic counting, and level and density control. It is provided with pigtail leads to save space and for versatility in mounting. Maximum dissipation is 250 mw. Average cell current is 10 ma. **Semiconductor & Special Purpose Tube Div., Amperex Electric Corp.,** 230 Duffy Ave., Hicksville, L. I., N. Y.

Circle 458 on Page 35



Reversing Motors

Rapid reversing motors are available in complete line of integral hp, polyphase ratings offered in open drip-proof, totally enclosed fan-cooled and nonventilated en-

This large Midwestern wholesale house uses four lines of QIK-TIP sorters to sort 12,000 pieces an hour to 400 destinations. The entire operation is easily done by a crew of 12 people. Further, the company has consolidated the operation of six separate warehouses under one roof and one modern system.

TRANSISTOR RADIO KIT

"QIK-TIP" SORTER

Automatically sorts and distributes up to 60 pieces a minute

The QIK-TIP Sortation System brings the advantages of modern, electronic automation to package handling in assembly plants, parts depots, warehouses, terminals and delivery services of all types. It cuts time, labor and the cost of human error to the bone. Here are two installations.

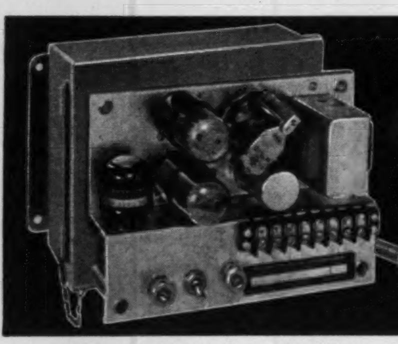
Write for descriptions of other applications or ask for a personalized analysis of your own sorting problem.

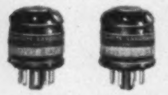
SPEAKER
SORTATION SYSTEMS
INC.

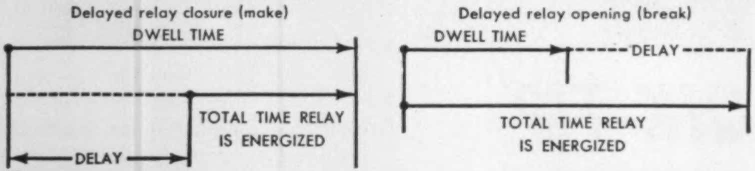
4535 No. 128th. St., Butler (Milwaukee), Wis.

The QIK-TIP sorter is extremely flexible. Here, it is used to minimize handling—and human error—at a mail terminal. Tilting trays roll or slide sacks gently into bins. No drops . . . no "swat-off" mechanism.

Circle 708 on Page 35







Delayed relay closure (make)
DWELL TIME
TOTAL TIME RELAY IS ENERGIZED
DELAY
Delayed relay opening (break)
DWELL TIME
DELAY
TOTAL TIME RELAY IS ENERGIZED
0623

NEW EPL TIME DELAY
Proximity Switch

WITH PLUG-IN MODULES

Choice of 2 Time Delay Modules

4906-JIC Control Amplifier with 4913-BL Sensing Head

Actuated by NON-MAGNETIC and MAGNETIC metals to solve varied control problems

Built-in time delays eliminate costly timing relays . . . give maximum flexibility at minimum cost.

Write for New Detailed Bulletin EDPS-80!

Electro CHICAGO

ELECTRO PRODUCTS LABORATORIES, 4501-A Ravenswood, Chicago 40
Canada: Atlas Instrument, Ltd., Toronto
Proximity Switches · Magnetic Pickups · Tachometers · DC Power Supplies

Circle 709 on Page 35

A TURN FOR THE BETTER
P.D.C. "AUTOMATIC" INDEX TABLE

DIAMETER
15″

NUMBER OF STATIONS
Standards:
*3, *4, 6, 8, 12
Specials:
*5, 7, 9, 10, 11
*skip station units

PDC-AM—15″ SERIES
"AUTOMATIC"
Geneva Motion Index Table

COMPLETE with air motor, solenoid valve, limit switch, 3 relays and enclosure, airline oiler and airline filter . . . all that is necessary to interlock it with other automatic equipment.

MODIFICATIONS available with Electric Drive, Fluid Drive or vertical mounting.

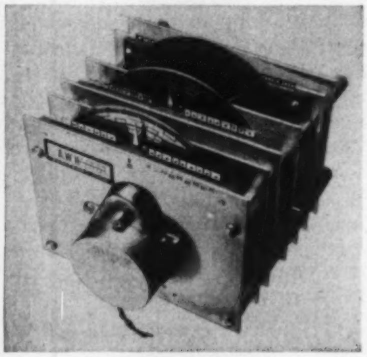
Write TODAY for new Catalog 60, for designers and engineers

PRECISION DETROIT COMPANY
20100 SHERWOOD · DETROIT 34, MICHIGAN

Circle 710 on Page 35

closures. They are also available in blower-cooled constructions that incorporate an integrally mounted blower to supply a continuous unidirectional supply of air for maximum cooling and reversing capacity. Primarily designed for high production machine tool applications, these motors offer up to 125 idle reversals per minute in the smaller sizes with open type construction, and they can be built to exceed 200 idle reversals per minute with blower cooled designs. Features include stator and rotor construction designed to reduce losses and give maximum reversals combined with long motor life, Class A insulation with special Class B and H available for special high reversing capacity motors, multispeed designs for slow infeed speeds along with faster withdrawal speeds as in the case of drilling and tapping machines, and rolled shell shaftless designs for compact direct built-in drives. **Louis Allis Co.**, Dept. P, 427 E. Stewart St., Milwaukee, Wis.

Circle 459 on Page 35



Binary Code Generators

Designed to present accurate electrical output signals in digital coded form, binary code generators are basically shaft position encoders which convert analog data in the form of shaft position angles into digital output represented by a coded pattern of electrical signals. Although units presently in production are basically binary time coded, many types of output code (pure binary, excess three, gray, or cyclic), as well as wide ranges of timing periods, different drive systems, a large selection of ac and dc timing motors or stepper motors and various types of control and accessory equipment can be combined to satisfy a wide variety of specific requirements. All models are available open, enclosed, or sealed with digital or clock face readout and manual or electrical adjustability as required. A wide range of binary time encoders and signal generators can also be supplied. **A. W. Haydon Co.,** Waterbury, Conn.

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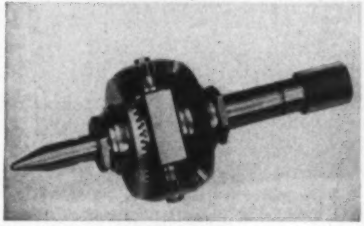
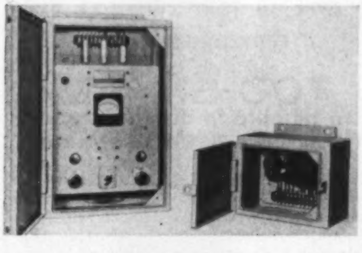


Miniature Differential

Precision mechanical differential is designed for loads up to 75 inch-ounces and speeds to 3500 rpm. It is ideally suited for use in servo systems and for integrating mathematic functions in computing equipment. Employing precision bevel gearing, backlash is held to 1½ minutes with a 0.5 inch-ounce checking load. Starting torque is kept to a relatively low value of 0.1 inch-ounce. Hollow shaft construction of the device makes various operating configurations possible. A wide range of end gear ratios are available. **Bowmar Instrument Corp.,** 8000 Bluffton Rd., Ft. Wayne, Ind.

Circle 461 on Page 35



Load Monitoring Device

Electronic ac load monitoring device, TorqueTrol, will provide continuous monitoring of ac motor load, detecting extremely small loading changes. Typical applications include such uses as: Protect-

NOPAK® OFFERS YOU COMPLETE AIR CIRCUITRY

another Plus Value by NOPAK

NOPAK "V"

NOPAXAM

NOPAK-MATIC

The addition of Nopaxam palm button, cam, lever and air operated valves "closes the Nopak circuit." Precise control — mechanically or electrically signaled — can now be *completely* Nopak. Singularly or in combination, Nopaxam, Nopak "V" valves and Nopak-matic valves will meet your most complex circuit requirements.

Nopak "V," 4-Way, Pilot Operated Slide Valves

For direct or remote control. Either single or double air pilot or solenoid actuated. Simple, proven design, durable construction insure trouble free operation. See Catalog 102-A.

Nopaxam Precision Spool Valves

For air or hydraulic service to 150 psi. Pilot or mechanically operated, these valves are small, compact, easily mounted, have extremely short throw and high flow rates. See Catalog N.

NOPAK-MATIC Poppet-Type, Pilot Operated Valves

Fast acting, high volume air valves from ¼" to 1¼" with master (air piloted), single or double solenoid. Side or bottom ported subplates or manifolds. Removing cover plates affords easy access to piston poppets housed within removable, interchangeable cartridges. 100% J.I.C. See Catalog 105.

Other NOPAK "CVA*" Products

NOPAK Class 1 Cylinders

Brass Tubing and Tie-Rod Construction. For pressures to 250 psi. Choice of adjustable cushion, self-regulating or non-cushion heads. Diameters from 1½" to 16". 6 Standard Mountings. See Catalog 101-A.

NOPAK Class 6 Bore-Rated Cylinders

Compact steel plate, square head with tie-rod and honed steel tubing construction. For air pressures to 250 psi. hydraulic pressures to 1500 psi. See Catalog 106.

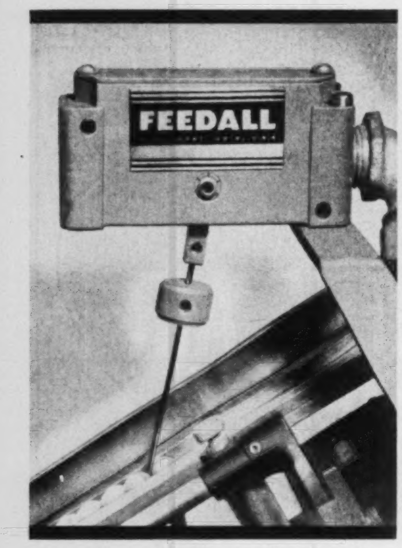
NOPAK Class 7, Square Barrel Cylinders

Made with pressure-cast and extruded aluminum. Mounting holes can be drilled or tapped directly into cylinder tubing. ¾" to 3" bores pressure rated for 200 psi. air or 1000 psi. oil. 7 universal mountings. See Catalog 107.

*CVA Cylinders, Valves, Accessories
NOPAK offers a complete line of Matched Fluid Power Components.

NOPAK VALVES & CYLINDERS

NOPAK DIVISION
Galland-Henning Mfg. Co.
2734 S. 31st St., Milwaukee 46, Wis.



ONLY

1/3 OZ. PRESSURE
8° MOVEMENT

actuates this rugged bank control switch

Feedall Model 110

- provides regulated parts flow for automatic operations.
- has adjustable sensing arm to fit varying work ranges.
- is virtually unaffected by dirt, dust or light.

The Feedall Model 110 is an exceptionally reliable, pressure-actuated control switch. It operates start-stop circuits and regulates flow rate in scores of automatic control systems.

The sensing arm is equipped with an adjustable counter-weight, permitting simple regulation to suit pressure requirements. A totally enclosed mercury switch combines reliability with a minimum of moving or sliding parts.

Like all Feedall products, the Model 110 switch is built and tested for rugged duty with surprising savings. Write for details.

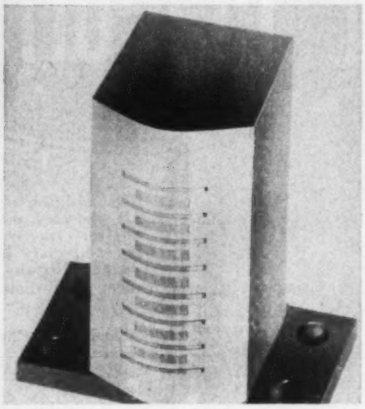
Feedall
Designers and builders of automatic feeding devices

38399 PELTON ROAD
WILLOUGHBY, OHIO

Circle 712 on Page 35

ing machine tools against damage due to jamming, misfeed, etc.; detecting excessive power on power presses; controlling feed rate on a grinder; warning of a dull tool or a tool break. Relay-type output can be used to stop motors; operate alarm or signal systems; count work cycles, etc. **Clark Controller Co.**, 1146 E. 152nd St., Cleveland 10, Ohio.

Circle 462 on Page 35

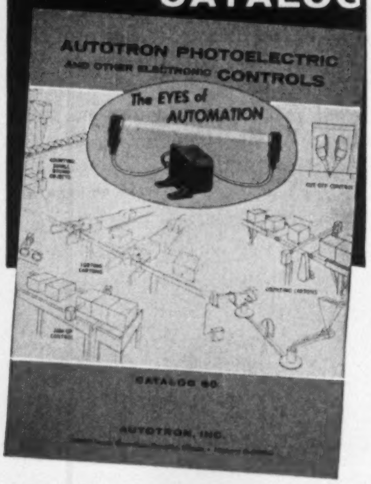


In-Line Magnetic Heads

Series of basic multichannel heads provides for simultaneous recording of up to 20 channels per inch on tape or drum. Designated as Series 4000, these heads are available in 6 compatible track formats with track widths of from 0.020 to 0.050 inch and track spacings of 0.050 to 0.140 inch. They provide 7, 8, 13, 14, 16, and 20 in-line channels per inch. Tight control of these parameters is maintained to tolerances of ±0.002 inch which allow for reliable interchangeability of tapes between equipment. Timing accuracy or recorded information between channels is assured by maintenance of colinearity of leading and/or trailing edges of gaps to ±0.000050 inch within the head stack. Further, control of perpendi[illegible]arity of the gap line and head [illegible] are held to within ±5 minutes of arc relative to the mounting surface. A choice of electrical characteristics is available for record, reproduce, and combination record-reproduce functions for both analog and digital recording. **Brush Instruments**, 37th and Perkins, Cleveland 14, Ohio.

Circle 463 on Page 35

NEW
PHOTOELECTRIC
CATALOG



Describes wide selection of heavy duty industrial photoelectric equipment including transistorized and conventional controls with light sources and remote heads for all kinds of applications. Also large selection of simplified diagrams covering widely varied applications. Send for your copy today.

AUTOTRON, INC.
Box 722 RR Danville, Ill.
Hickory 6-0650 TWX: DANV ILL 7338

Circle 713 on Page 35

If your product is . . .

TOO BIG
for use by a salesman or in a trade show.

TOO HEAVY
for a salesman to carry.

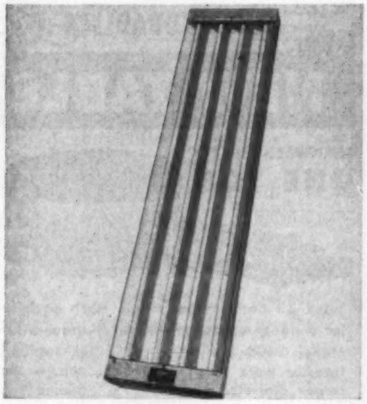
TOO EXPENSIVE
to give to your salesman and representatives.

TOO SMALL
to be able to demonstrate its features to the customer.

Used as a selling tool, a scale model will solve all these problems • A model can be constructed to show the features of your product where very often the actual article is not suitable • A picture is worth a thousand words • A model is worth a thousand pictures • Write for brochure describing how scale models can open doors and sell your product.

"VISUAL" Plant Layouts, Inc.
99 Pennsylvania Ave.,
Oakmont, Allegheny County, Penna.

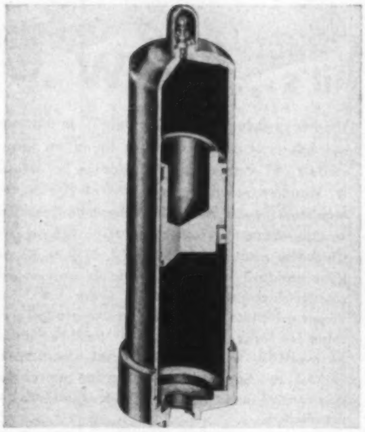
Circle 714 on Page 35



Quartz Heating Panels

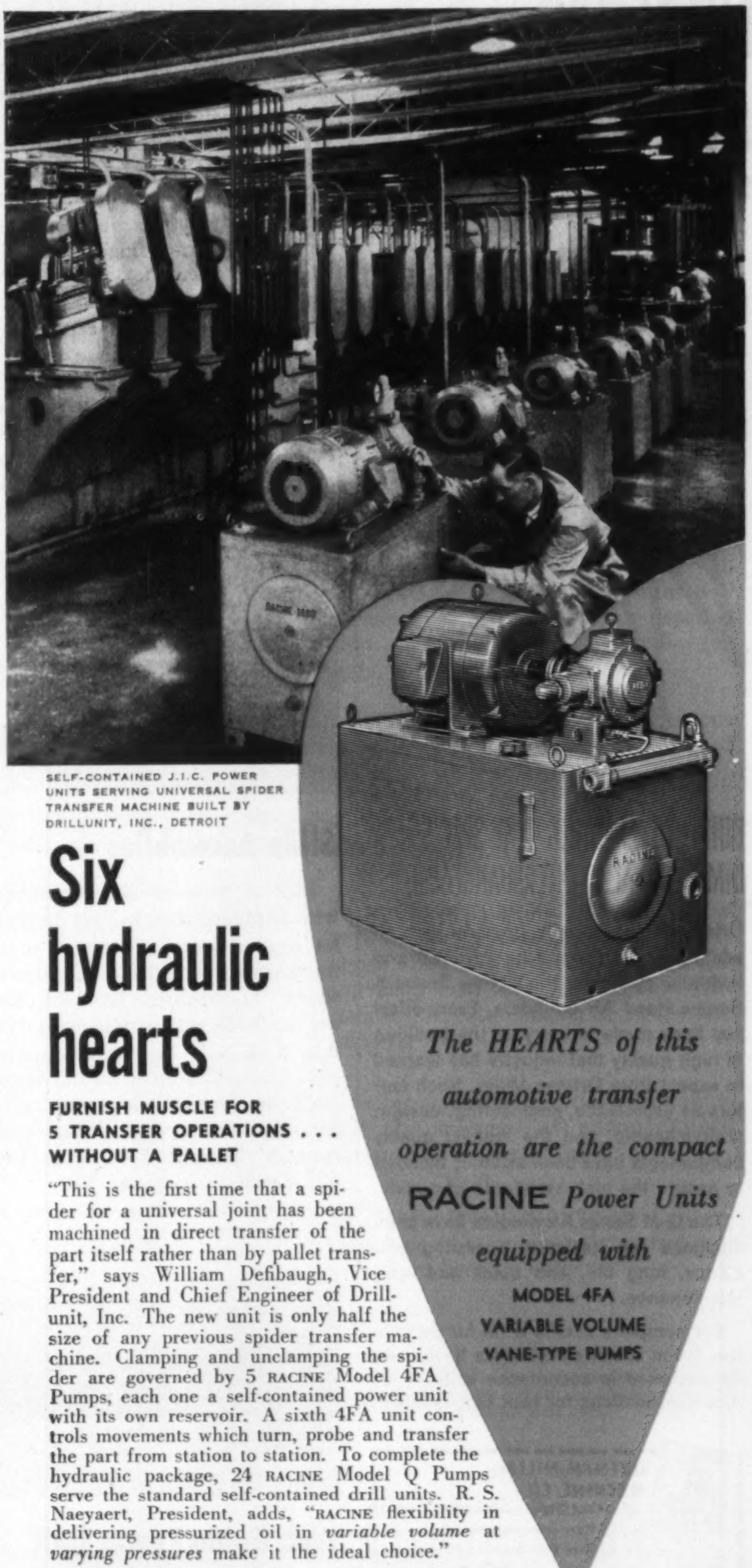
Panels contain one to four Clepcofused quartz radiant heating elements. They come in standard lengths of 2 to 6 ft and from 4 to 12 in. in width. Wattage can vary to requirements. Heating element can be varied up to 1700 F. Aluminum reflectors are of the snap-out type and are backed up with 2-inch insulation. Panels are surface angled to obtain even distribution of reflected radiation. Panel ends have ceramic standoff connectors with stainless steel studs and lockwashers and nuts. They can be fitted in any oven. Wiring conforms to National Electric Codes and J.I.C. Standards. **Cleveland Process Corp.,** 1773 E. 21st St., Cleveland 14, Ohio.

Circle 464 on Page 35



Hydraulic Accumulator

Three functions are performed by this oil-hydraulic accumulator. One is that of a power storage



SELF-CONTAINED J.I.C. POWER UNITS SERVING UNIVERSAL SPIDER TRANSFER MACHINE BUILT BY DRILLUNIT, INC., DETROIT

Six hydraulic hearts

FURNISH MUSCLE FOR 5 TRANSFER OPERATIONS . . . WITHOUT A PALLET

"This is the first time that a spider for a universal joint has been machined in direct transfer of the part itself rather than by pallet transfer," says William Defibaugh, Vice President and Chief Engineer of Drillunit, Inc. The new unit is only half the size of any previous spider transfer machine. Clamping and unclamping the spider are governed by 5 RACINE Model 4FA Pumps, each one a self-contained power unit with its own reservoir. A sixth 4FA unit controls movements which turn, probe and transfer the part from station to station. To complete the hydraulic package, 24 RACINE Model Q Pumps serve the standard self-contained drill units. R. S. Naeyaert, President, adds, "RACINE flexibility in delivering pressurized oil in *variable volume* at *varying pressures* make it the ideal choice."

The HEARTS of this automotive transfer operation are the compact RACINE *Power Units equipped with*

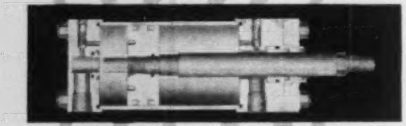
MODEL 4FA
VARIABLE VOLUME
VANE-TYPE PUMPS

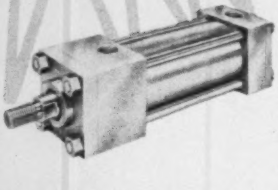
RACINE

Racine Hydraulics & Machinery, Inc.
RACINE, WISCONSIN
HYDRAULICS DIVISION

Circle 715 on Page 35

NEW O-M
AIR CYLINDER
Series K·200 psi
1½" to 14" Bores
Meets JIC Standards





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Ortman-Miller proudly presents, as an addition to its famous family of air and hydraulic cylinders, the all new Series K Square Head Air Cylinders. Every effort has been made to carry on the tradition of high quality that industry has learned to expect from Ortman-Miller. Such factors as experience, engineering, design, craftsmanship, and the highest quality components have been skillfully blended to assure the high standards of quality.

The O-M Series K cylinders have been designed for maximum operating efficiency, long life, and quick and easy maintenance.

For complete details write for Bulletin No. 115 in which all cylinders have been dimensioned in accordance with NFPA recommendations for your convenience.

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☐ Have representative call.
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Company________
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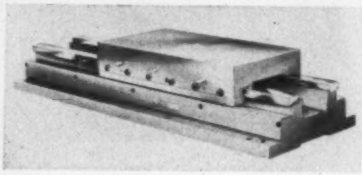
Circle 716 on Page 35

chamber so a low volume pump can supply a large amount of energy for a brief moment. The second is that of a pressure compensator to maintain system pressure so holding cylinders do not lose their grip. The third is to eliminate surge and vibration, smooth out pressure pulses, and prevent shock from fast-closing valves. Six models are offered for 3000-psi service, four others for 3500-psi service. Stock sizes range from 1 pt to 2½ gal over-all. Oil volume is 29 to 230 cu in. for the 3000-psi models, 230 to 575 cu in. for the others. Unit features a no-weld, one-piece outer shell, and a statically balanced piston. **Crescent Hydraulic Co.,** 1303 Otsego Rd., Allegan, Mich.

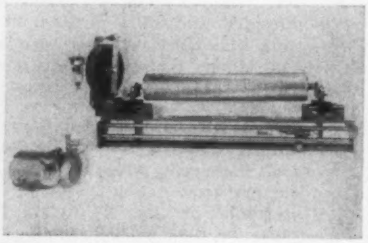
Circle 465 on Page 35



Slide Assemblies

Line of precision slide assemblies with hardened steel ways is designed for heavier loads and longer maximum stroke lengths than dovetail slides. Thirty-three standard sizes are available with saddle areas from 9 by 9 in. to 15 by 30 in. Maximum stroke length is up to 45 in. Auxiliary equipment includes power cylinder, lead screw, and electric cycle controls. **Russell T. Gilman Inc.,** 623 Beech St., Grafton, Wis.

Circle 466 on Page 35



Web Guide Power Unit

Vacuum operated diaphragm type power unit, Model D-10A, is used with a Kamberoller assembly to intermediately guide a moving web of

AIR-HYDRAULICS INCORPORATED
NEW TABLE
HANDLES UP TO
ONE TON

Index 30 positions per minute when equipped for 6 station operation with Air-Hydraulics' new Model 2400 (24" dia.) air index table ● Handles work loads up to one ton ● Bolt larger diameter plates to 1¼" ground steel table top for greater table area ● Repetitive shock loads are no strain ● 4" bore index cylinder develops power stroke 13 times line pressure for extra power and speed—no override ● Adjustable cushion and speed control ● Locking cylinder, mounted on table's centerline, means positive index every time— =.0015" ● Limit switch keeps basic equipment from moving until table is "locked in" ● Pressure lubrication, tapered roller bearing on shaft and ample bearing surface at circumference assure friction free operation ● Operates on 60 to 175 psi line pressure ● 4, 6, 8 or 12 stations with clockwise rotation standard ● Others, including counterclockwise rotation, and from 3 to 60 positions to order.

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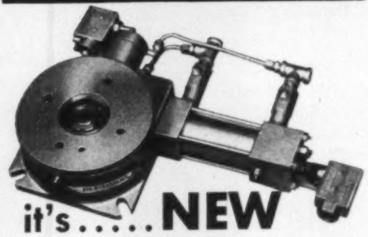

it's.....NEW

The heavy duty Model 700 is only 7" in diameter but has most of the features found on larger models ● Makes up to 75 indexes per minute ● Handles maximum work load of 100 lbs. ● Maximum power stroke is 3 times line pressure ● Operates on pressures from 60 to 175 p.s.i. ● Clockwise rotation with either 4, 6, 8 or 12 stations standard ● Others up to 24 stations and counter-clockwise rotation, to order ● Bolt larger sub-plate (up to 14" dia.) to ground steel table for larger work area ● Positive index—no override ● Adjustable cushion and speed control ● Each table checked for guaranteed accuracy of index (± .0015"), concentricity and parallelism.

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AIR-HYDRAULICS INCORPORATED
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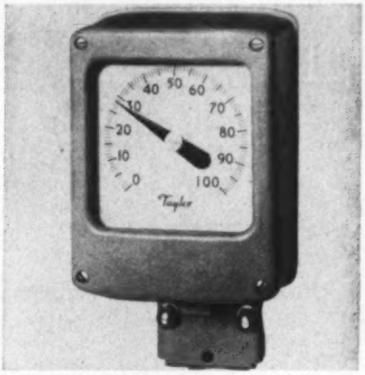
JACKSON, MICHIGAN

Circle 717 on Page 35

flexible material. The power unit is an integral part of a complete package that is ready for installation on a web converting machine. Included with the power unit is the Kamberoller assembly (with either single, double, or nip rollers), motor-vacuum pump, sensing head, sensing head mounting bracket, tubing, and fittings. This complete assembly is used for intermediate guiding of narrow webs of paper, tag stock, or light weight board on web fed presses, business forms presses, bag machines, coaters, laminators, or other web fed machines. This particular unit is limited to use on webs with a maximum width of about 24 in. **Fife Mfg. Co. Inc.**, P. O. Box 9815, Oklahoma City 18, Okla.

Circle 467 on Page 35



Pneumatic Transmitter

High-accuracy pneumatic transmitter provides an input-to-output accuracy of ½ per cent in the measurement of gage pressure, volumetric pressure, temperature, and volumetric load. Feature of the device is a sealed cartridge servo unit designed to maintain high transmission accuracy under load. Exceptionally low friction encountered in the sealed indicator-driving mechanism permits a 0.1 per cent of input-span sensitivity to, and little deterioration of, low-energy input signals. A large, 11¾-inch scale, easily readable at 35 feet, provides an indication accuracy within 1 per cent of actual value of the variable being measured. The 3-15 psi transmitter output may be fed directly to other indicating, recording, or controlling stations. **Taylor Instrument Companies,** 95 Ames St., Rochester 1, N. Y.

Circle 468 on Page 35

TRANSACTER

at BOEING

Remote source data collection — a bottle neck in Electronic Data Processing in many "big plant" operations — is no problem at Boeing's Transport Division, Renton, Washington.

We quote, in part, from **BOEING NEWS**, January 12, 1961: "The decision to install the entire network (TRANSACTER* System) came as a result of successful tests conducted . . . by Boeing employees and representatives of Stromberg, manufacturer of the entire system.

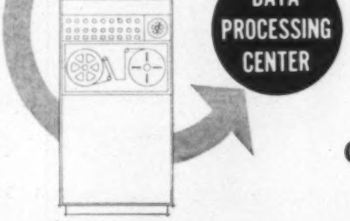
"Types of information that employees will 'feed' to the data collecting nerve center will include personal attendance data and detailed information of time spent on specific job assignments.

"The information will receive instantaneous treatment at the nerve center regardless of its origin.

"Some of the advantages of the system include the following:

1. Rapid gathering and processing of production information from factory shops. This data is vital in determining shop load and performance factors and in establishing accurate cost targets.
2. Greater accuracy in reports by reducing the margin of error caused through extra handling".

With the TRANSACTER System dramatic new opportunities for cost reduction become evident.



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Circle 718 on Page 35

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Circle 719 on Page 35

AUTOMATION catalogs and literature

Latest automation information. For copies use card on page 35.

Chucking Machine

Brown & Sharpe Mfg. Co., Providence 1, R. I.—4 page pamphlet—Subject of Bulletin SM45 is a No. 2 automatic chucking machine, designed to perform facing, forming, turning, drilling, and threading operations. Work up to 3 inches in diameter can be gripped internally or externally in its air-operated chuck. Round, square, hex, or irregularly shaped parts, such as castings, forgings, slugs, stampings, and molded, cold headed, and powdered metal parts can be handled. Schematic diagrams illustrate machine dimensions as well as typical parts produced.

Circle 469 on Page 35

Remote Handling Equipment

General Mills Inc., 419 N. 5th St., Minneapolis 1, Minn.—24 page handbook—Bulletin 6B135 describes a line of electromechanical, remote handling devices for use in hazardous working environments. Details are provided on six standard mechanical arms and related equipment. Mounting versatility of the devices is discussed as well as mechanical arms vehicular concepts and systems applications. Various industrial applications are illustrated.

Circle 470 on Page 35

Hardness Testers

Wilson Mechanical Instrument Div., American Chain & Cable Co. Inc., 230 Park Ave., New York 17, N. Y.—24 page handbook—Catalog RT-60 contains information on the principle of the Rockwell hardness test and of microhardness testing. It illustrates and describes Rockwell and Superficial hardness testers, and Tukon microhardness testers. Also illustrated and described are several hardness testing models designed for specific uses: fully automatic models, motorized models for testing at elevated temperatures, internal hardness testing, a mobile tester, diamond Brale penetrators; and various Rockwell accessories.

Circle 471 on Page 35

Vertical Milling Machine

Milling Machine Div., Cincinnati Milling Machine Co., Cincinnati 9, Ohio—18 page booklet—Catalog M-2165 describes a vertical Hydro-Tel milling machine that has the versatility and adaptability for general purpose, manually controlled milling, die sinking, automatic profile milling, and multiple spindle production milling. The machine has a new cross slide and vertical head, with horsepower ratings 50 to 100 per cent greater than before. Table and cross slide feeds are infinitely variable from 1 to 25 ipm or ½ to 12½ ipm; vertical head feeds range from 1 to 15 ipm. There are 16 spindle speeds, six optional ranges for the 10 and 15 hp drives, and four for the 20 hp drive.

Circle 472 on Page 35

Counting Instruments

Automation Controls Div., General Controls Co., 8080 McCormick Blvd., Skokie, Ill.—6 page pamphlet—Catalog 608.462 covers electric, stroke, turn, revolution, and coil winding counters, as well as counter actuators. It describes and illustrates dustproof and hermetically sealed coil counters, automatic batch counters, actuating switches, and photoelectric equipment.

Circle 473 on Page 35

Motor Drives

Falk Corp., Box 492, Milwaukee 1, Wis.—36 page catalog—Bulletin presents shaft mounted drives and a series of flange mounted drives covering a torque range up to 44,000 lb inches. Design and construction advantages are included as well as selection and dimensional data, engineering drawings, accessories, and typical application photographs. Also explained and illustrated is a line of Equi-Poised motor mounts for use with the drives. These compact, steel weldments are predrilled to accommodate rerated footmounted NEMA motors (½ to 30 hp).

Circle 474 on Page 35

Transducer Products

Avionics & Industrial Products Div., Lockheed Electronics Co., 6201 E. Randolph St., Los Angeles 22, Calif.—16 page booklet—Individual fact sheets present specifications, performance characteristics, circuits, and price information on a line of strain gages and multipliers, load cells, force washers, high sensitivity washers, and position transducers. Photographs illustrate the various devices.

Circle 475 on Page 35

Pinboard Programming Panel

AMP Inc., Harrisburg, Pa.—2 page pamphlet—Product information Bulletin 600 describes a pinboard programming panel designed for applications such as automated machine tools, instrumentation, tests and checkout equipment, controls, and data processing equipment. Through the use of appropriate permanent wiring on the rear of the board, circuit-commoning functions and maxtrix programming can be easily accomplished. Contact springs can be interconnected in any variation desired. Panels can be made with as many matrixes as desired, in a great variety of sizes and grid arrangements.

Circle 476 on Page 35

Engine Lathes

R. K. LeBlond Machine Tool Co., Madison at Edwards Rd., Cincinnati 8, Ohio—16 page booklet—Bulletin describes a line of Tape Turn lathes with headstocks and carriages designed to accept commands from a Mark Century solid state numerical control system. These lathes can turn contours, tapers, sharp angles, and facing cuts all under tape control. Six tools are carried in the numerically controlled tool turret—enough to perform all roughing and finishing operations on most jobs. Bulletin includes several schematic diagrams and specification charts.

Circle 477 on Page 35

Case Imprinters

J. L. Ferguson Co., Sales Dept., P. O. Box 1226, Joliet, Ill.—2 page pamphlet—Data Sheet 100-59 contains information on a line of Packomatic case imprinters which print brand names, case contents, deal or lot numbers, serial numbers, or other identification on shipping cases automatically as part of in-line production. Machines imprint any or all four case side and end panels.

Circle 478 on Page 35

Solid State Alarm Unit

San Diego Scientific Corp., 3434 Midway Drive, San Diego 10, Calif.—4 page pamphlet—A solid state alarm unit, designated Magne-Alarm, is subject of this brochure. The alarm provides a reliable solution to temperature monitoring problems in the chemical, metalworking, steel, oil, nuclear, and electronic industries. It uses a bistable magnetic amplifier as its only active element. Lamps normally glow dimly and brighten for alarm. Unit will not trip on random noise.

Circle 479 on Page 35

Autographic Plotters

Gilmore Industries Inc., 13015 Woodland Ave., Cleveland 20, Ohio—8 page bulletin—Bulletin PG-100 describes a line of multirecord autographic plotters. This line includes standard, high speed, and extra high speed strain gage plotters; modular plotters, and segmental recorder and scanner plotters. Savings in test time and fast evaluation of tests obtained with visual data plotted by these devices are explained.

Circle 480 on Page 35

Form Grinders

Jones & Lamson Machine Co., 160 Clinton St., Springfield, Vt.—6 page pamphlet—Data are contained in this bulletin on two automatic form grinders, featuring perpetual form control for wheel truing. Model E-2 uses standard truing devices and is specifically designed for high-production, precision plunge grinding on shaft work up to 31 inches in length. It is also adaptable for other types of between-centers work, as well as chucking work and jobs requiring external, shoe-type support. Model E-3 has a new type of vertical truing device which offers a full 12 inches of wheel spread with perpetual form control. This model is ideally suited for high-production, precision plunge grinding of widely spaced grooves.

Circle 481 on Page 35

Circuit Breakers

I-T-E Circuit Breaker Co., 1900 Hamilton St., Philadelphia, Pa.—10 page bulletin—Design features of K-Don current-limiting circuit breakers are detailed in Bulletin 4300-1A. Line combines 200,000 amperes interrupting capacity with complete range of operation of K-Line low voltage circuit breakers. Features of the breakers are high-speed protection for high capacity faults, instantaneous tripping for medium capacity faults, time delay tripping for medium and low capacity faults, and direct-acting impact trip on high capacity faults.

Circle 482 on Page 35

Clamping Cylinders

Airmatic Valve Inc., 7313 Associate Ave., Cleveland 9, Ohio—4 page pamphlet—Bulletin 91036 describes a line of single or double acting clamping cylinders capable of withstanding air pressures from 0-150 psi. The cylinders are available in the following bore sizes: 1½, 2½, and 3 inches. Schematic diagrams illustrate construction features of the devices.

Circle 483 on Page 35

Tube Fittings

Lenz Co., 3301 Klepinger Rd., Dayton 1, Ohio—24 page catalog—Catalog TF-1060 details a line of tube fittings, accessories, and typical applications. Featured is an "O-Ring Seal" line. Back pages of the catalog are devoted to cutaway illustrations and descriptions of this seal's adaptability in some typical, difficult design or maintenance situations. Catalog covers J.I.C. approved tapered pipe, S.A.E. straight thread fittings, and tube reducing adapters all utilizing the "O-Ring Seal". Also covered are J.I.C. approved 3 piece, 37-degree flare tube fittings in tapered pipe and S.A.E. straight thread; standard steel pipe fittings, valves, hydraulic pressure gages, oil fill and filter cap assemblies, tube benders, and other hydraulic accessories and tubing.

Circle 484 on Page 35

Explosion Protection Systems

Fenwal Inc., Ashland, Mass.—8 page bulletin—Bulletin MC-172 discusses in detail what an explosion protection system is, what it can do, and where it can be used. Schematic diagrams illustrate applications of various methods of explosion prevention by: Suppression, isolation, advanced isolation and suppression, venting and advance inerting, advance inerting, suppression and venting.

Circle 485 on Page 35

Electrical Switches

Licon Div., Illinois Tool Works, 6606 W. Dakin, Chicago 34, Ill.—32 page catalog—Catalog 1110 provides data on a line of precision snap-action switches. Basic sensitive switches, miniature and 10 amp rated subminiature units, heavy duty models, enclosed limit switches, and a complete line of auxiliary actuators are described. Electrical ratings, dimensions, switch life, and operating characteristics are given for all basic switches. Descriptions of hermetically sealed and environment free switches are also provided.

Circle 486 on Page 35

Electric Tachometers

Electro-Mechano Co., 241 E. Erie St., Milwaukee, Wis.—4 page pamphlet—Bulletin provides data on a line of electric tachometers suitable for a wide variety of applications in transportation, industrial processing, production control, machine tools, marine equipment, testing, and laboratory work. These devices are particularly useful where the indicator is to be located at a distance from the point of speed measurement. Various available models are illustrated and described.

Circle 487 on Page 35

Turret Drill

Cincinnati Lathe & Tool Co., 3207 Disney St., Cincinnati 9, Ohio—8 page bulletin—Turret drill, designated Cintimatic, is described and illustrated in Catalog N-260. This six-turret numerically controlled machine provides complete automatic drilling for a wide range of work. In addition to worktable positioning, the Acramatic console controls tool selection, feed, spindle speed, hole depth, and tapping cycle. A tool length compensator adjusts for work height and tool length.

Circle 488 on Page 35

Plating Barrels

Hanson-Van Winkle-Munning Co., Church St., Matawan, N. J.—collection of data sheets—Bulletin PB-111 contains nine plating barrel and accessory equipment data sheets. Details are provided on the following equipment: Mercil-type portable barrels; special barrel equipment, Mercil-type hanger equipment; hanger mounted motor drive equipment; cylinder materials

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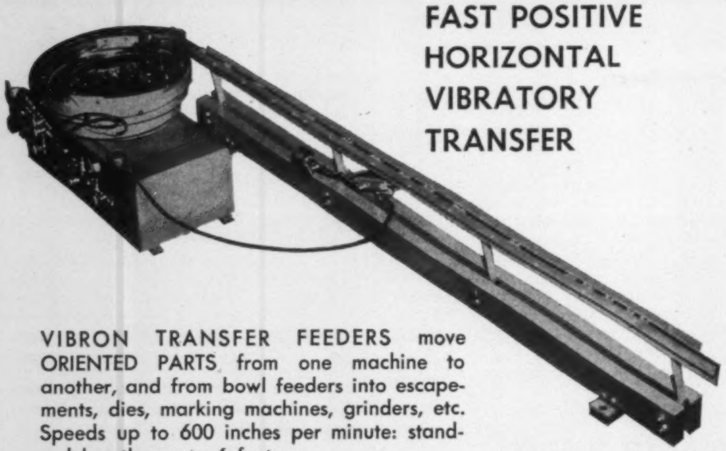
Circle 720 on Page 35



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Circle 721 on Page 35

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Circle 722 on Page 35

and construction; plating barrel contacts; tank and drive equipment and tank transfer equipment. A final bulletin gives specifications for all standard model barrel units and all Mercil-type model MH barrel units. Features of Plexiglas cylinders are discussed. These cylinders have one-inch heads and half-inch panels and are ribless and molded in one piece. They can be used for all solutions (except chromium) where temperatures do not exceed 180 F.

Circle 489 on Page 35

Air Line Components

Hannifin Co., Dept. 142, 501 *S. Wolf Rd., Des Plaines, Ill.*—20 *page booklet*—Bulletin 0400-B1 provides listings as well as simplified engineering and application data on Crown filters, regulators, and lubricators. It highlights new self-drain filters, pilot controlled regulators, and matched Combo units. Each unit is completely diagrammed, and is accompanied by dimensional drawings and tables. Full information about Crown accessories available to increase unit versatility and a parts identification section are also included.

Circle 490 on Page 35

Soldering & Brazing Processes

Fusion Engineering, 17921 *Roseland Ave., Cleveland* 12, *Ohio*—4 *page pamphlet*—Covered in this bulletin are methods of automating production soldering and brazing operations with paste alloys. Three series of available paste materials are described. The bulletin cites four case history examples of cost savings achieved through installation of automatic, semiautomatic, and manual equipment using the paste alloys.

Circle 491 on Page 35

All-Metal Gas Catalysts

Catalytic Combustion Corp., 4725 14*th St., Detroit* 8, *Mich.*—4 *page pamphlet*—Details on a line of all-metal gas purification catalysts and reactors are contained in Bulletin G-61. The use of these catalysts to produce industrially pure gases is described. Removal of impurities to less than 1 part per million can be achieved. The catalysts operate at high or low pressure, and at temperatures up to 1500 F. Typical applications described include: Purification of generated atmospheres; H_2, O_2, CO, nitrogen oxides, and hydrocarbon removal from process gases, and nuclear plant recombiners.

Circle 492 on Page 35

Computer Subsystems

Computer Engineering Associates Inc., 350 *N. Halstead, Pasadena, Calif.*—8 *page bulletin*—Bulletin SCE-1 provides data regarding four new products essential to data acquisition systems. These products include a true differential wideband dc amplifier with input terminals isolated from output terminals and all terminals isolated from ground. It amplifies dc to 20 kc signals at all gain settings and loads from strain gages, resistive transducers, and other low-level signal sources. Also described are a floating wideband amplifier (dc to 40 kc) with extremely low noise and high input impedance; a wideband impedance converter (1 cps to

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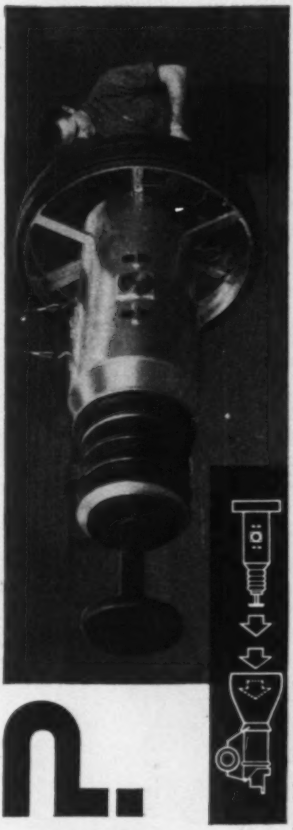
Pneuma-Grip® solves problem of removing and inserting engines without damage to highly sensitive surfaces. Pneumatic rubber rings contact maximum area at minimum psi.



Unit shown was developed for the Saturn Rocket Program being conducted by the George C. Marshall Space Flight Center, Huntsville, Alabama.

For 8-page descriptive catalog write:

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Circle 723 on Page 35

100 kc) which is a cathode follower with double isolation; and a differential isolator which is a dc to 20 kc transformer that converts a floating, 3-terminal wideband dc amplifier into a 4-terminal unit.

Circle 493 on Page 35

Time Delay Relays

Controls Div., Leach Corp., 18435 Susana Rd., Compton, Calif.—4 page pamphlet—Subject of Bulletin TD-200-660 is a line of time delay relays in a timing range of 100 milliseconds to 60 seconds. These electronic devices are available with either fixed or adjustable timing. Specifications include: Input voltage range, 21-30 v dc; accuracy (over all conditions), 10 per cent; recycle time, 50 milliseconds maximum; life, 100,000 cycles minimum. Units feature printed circuit construction, voltage compensation, and high environmental resistance.

Circle 494 on Page 35

Contour Milling Machines

Giddings & Lewis Machine Tool Co., Fond du Lac, Wis.—12 page booklet—Numerically controlled horizontal die sinking and contour milling machines are described in Catalog DM-115. Catalog lists operating advantages of numerical control and horizontal-spindle design, describes machine construction and control features, illustrates optional equipment, and includes basic specifications for 10 and 20-hp machines.

Circle 495 on Page 35

Digital Computers

Bendix Computer Div., Bendix Corp., 5630 Arbor Vitae St., Los Angeles 45, Calif.—4 page pamphlet—Bulletin SB 0860 describes two applications of a G-15 digital computer in refineries. The applications covered include computation of material balances; forecasting alkylation, polymerization, and outside butane requirements; analysis of heat-exchanger performance; and gasoline blending.

Circle 496 on Page 35

Vacuum Pickup Devices

Air-Vac Engineering Co., P. O. Box 27, Old Stratford Rd., Shelton, Conn.—4 page pamphlet—Bulletin explains how production operators can pick up and handle miniature parts of all shapes and materials rapidly with this Bazooka vacuum probe, which has a finger-operated shut-off valve for releasing parts from the probe tip. Probe tips are made of stainless tubing or plastic. Special tips are also available for picking up more than one part at a time. If vacuum is not available, a vacuum transducer converts shop compressed air into a vacuum. More than one probe can be used with the transducer.

Circle 497 on Page 35

Transfer Units

Livernois Engineering Co., 25200 Trowbridge, Dearborn, Mich.—8 page bulletin—Data are contained in this booklet on a line of mechanical or cylinder actuated in-line transfer devices. These building block transfer units can be arranged to fit all types of presses and special machines. They are adaptable to existing dies and easily incorporated into new designs. Several different models are described and illustrated.

Circle 498 on Page 35

Drive Tensioner

Brewer Machine & Gear Co., 1441-43 N. 2nd St., St. Louis 6, Mo.—4 page pamphlet—Data are contained in this bulletin on both base mounted S-Series Universal drive tensioners and shaft mounted A-Series Universal drive tensioners. The base mounted series, through the use of a rotating arm and adjusting slot, permits easy, accurately controlled tensioning at any point on a 360-degree arc. The shaft mounted series is ideal for locations where it is impractical to bolt a tensioner to the frame of a machine. Charts give specifications for a line of bronze bushed idler pulleys for use with V belts, flat belts, and timing belts and bronze bushed idler sprockets for use with roller chain.

Circle 499 on Page 35

Electric Heaters

General Electric Co., Schenectady 5, N. Y.—48 page catalog—Bulletin GEC-1005K lists product and application data for a line of Calrod Tubular, finned tubular, cartridge, strip, insertion, and vane heaters; forced and natural convection air heaters; and Form G and edgewound

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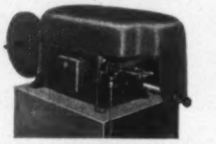

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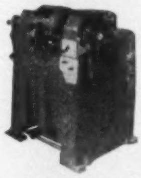

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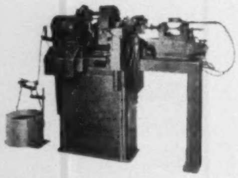

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- **Automatic, Semi-, or Manual . . .**
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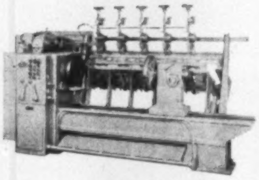

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The GLOBE TOOL and ENGINEERING Company

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Circle 724 on Page 35

oven heaters. In addition, there are sections on heater control and wiring diagrams. Application and heater selection are included in both long and short forms. Photographs and dimensional drawings are shown for almost all types of heaters.

Circle 500 on Page 35

Gages and Gaging Components

Federal Products Corp., 1144 Eddy St., Providence 1, R. I.—40 page catalog—Line of automatic gages and gaging components, featuring transistor operated gaging and control, is described in Catalog 60 AM. Complete machine control gages and automatic sorting gages are detailed in the first two sections of the catalog. A third section deals with gaging components, which serve as building blocks for incorporation into machine tools or special gaging devices. Mounting dimensions and specifications are given in a four-page supplement that accompanies the catalog.

Circle 501 on Page 35

Turret Drill

Fosdick Machine Tool Co., Cincinnati 23, Ohio—6 page pamphlet—Data are contained in Bulletin FTD-1 on a Fosmatic numerically controlled turret drill. Thirty-two spindles in a revolving turret hold enough tools for hundreds of drilling, tapping, and milling operations. Numerical control increases production and practically eliminates scrap with this machine.

Circle 502 on Page 35

Information Searching Service

American Society for Metals, Metals Park, Novelty, Ohio—8 page bulletin—Brochure provides details regarding an information searching service for retrieving data about metals from the whole world's technical literature, patents, and U. S. Government reports. This material is indexed and encoded on magnetic tape. Then an electronic selector is able to select those items of specific interest to each individual subscriber to keep him current in regard to his specific needs. Customer gets a comprehensive report every two weeks.

Circle 503 on Page 35

Pneumatic Load Cells

Harrob Industries, 414 Times Square Bldg., Seattle 1, Wash.—4 page pamphlet—Applications and functions of Weber air-weigh systems using pneumatic load cells are explained in this brochure. These systems are used for weighing, inventory control, mixing and batching, and solids flow control. They have applications in petrochemical, materials handling, aviation, and other industries.

Circle 504 on Page 35

Pneumatic Computing Relay

Fischer & Porter Co., 547 Jacksonville Rd., Warminster, Pa.—8 page bulletin—A pneumatic computing relay, designated Sorteberg Force Bridge, is the subject of Catalog 53CR1000. Detailed application data are listed for each of the computer's operations which include: multiplication, division, squaring, square root extraction, simultaneous multiplication and division, and ratio setting. Operation and design features are also described.

Circle 505 on Page 35

Automatic Sequence Control

Allen-Sherman-Hoff Co., 259 E. Lancaster Ave., Wynnewood, Pa.—4 page pamphlet—Data Sheet EEb describes the operation, application, and construction details of a compact automatic sequence control for pneumatic materials handling systems. Included are dimension drawings and a schematic diagram for a typical system of 12 hoppers, materials handling valves, and segregating valves.

Circle 506 on Page 35

Industrial Ovens

Electric Oven Div., Ramco Equipment Corp., 801 Edgewater Rd., New York 59, N. Y.—4 page pamphlet—A twin recirculation oven principle that provides uniform heat from all sides under full load conditions, sharply reduces heat-up time, and eliminates rejects due to faulty heat processing, is explained in Bulletin 960. Cross-sectional drawings show how all-around heat penetration of material is achieved with minimum temperature differential and elimination of heat pockets and stagnant spots. Details are also included on design advances in heaters, insulation, thermostatic controls, electrical control panels, exhaust, safety provisions, and material handling equipment.

Circle 507 on Page 35

Lahr AUTOMATIC PART UNLOADER

SAFE . . FAST removal of parts
from POWER PRESSES

A VITAL LINK IN PRESS AUTOMATION

VARIABLE STROKE • TIMED TO PRESS
UNIVERSAL DESIGN • LOW MAINTENANCE

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Circle 725 on Page 35

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Call your nearest Parker-Hannifin sales office, or write direct for complete information.

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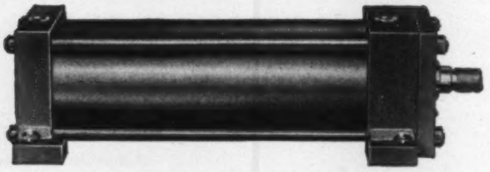
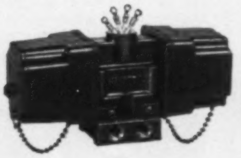
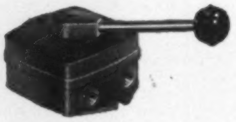


Low friction, long packing life are money-saving features of the Hannifin Series "A" pneumatic cylinder, available in a full range of mounting styles and from 1½″ to 14″ bore, strokes to 20 feet. Hannifin cylinder application data and charts make selecting the right Series "A" cylinder easy. Get yours from your Parker-Hannifin man.



DUAL SOLENOID, 4-WAY

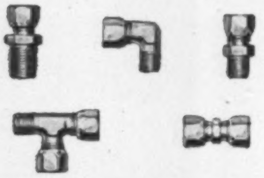
PRESSURE, 3-WAY



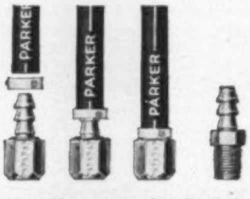
HAND, 4-WAY

CAM, 3-WAY

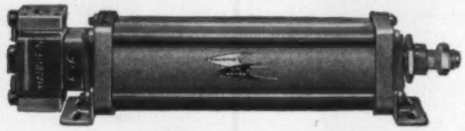
Use flow factors as money-savers—your Parker-Hannifin man can show you how. They help you to avoid "oversizing" your valves. Hannifin's new Valve Finder gives "C_V" ratings for every valve in the line, makes it possible for you to take full advantage of the extra air-flow capacity in Hannifin air valves. Get your copy today.



Pneumatic systems tube up fast with Parker "Intru-lok" tube fittings. Use them with copper, nylon or "Parker-POL" polyethylene tubing. Just insert the tube and tighten the nut for a leakproof "bite-type" joint.



Another time-saver is "Push-lok", the Parker hose-and-hose-fittings combination for pressures to 250 psi. No tools needed. Just push this hose on these hose fittings. They won't blow off, ever, not at twice 250 psi.



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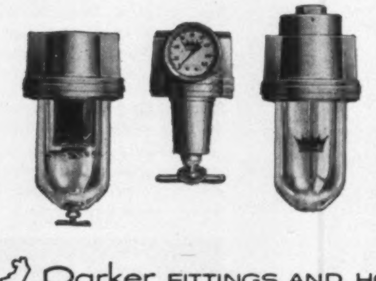

You will save both air and money with Hannifin "Crown" air line filters, pressure regulators and lubricators. Let your Parker-Hannifin man show you how they pay for themselves by making it possible to get all the air flow you need at the exact pressure that will best do the job. "Crown" filters and lubricators will bring further savings through reduced equipment maintenance.

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AUTOMATION abstracts

PLANT MODIFICATIONS FOR COMPUTER CONTROL

By CHARLES H. THURMAN
Agricultural Chemicals Div.
Monsanto Chemical Co.
Luling, La.

THE FINAL closing of the process loops for the ammonia unit at Monsanto Chemical Co.'s Barton Plant completed over two years of study, engineering, installation, and startup. The type of process and equipment controlled by the computer is shown in *Fig.* 1.

So far as plant modifications necessary for computer control, the first decision to be made was whether to keep existing pneumatic instruments or replace them with electronic types. The latter would be compatible to the computer whereas the pneumatic ones were not. It did not require much time and study to reveal that the expense of a completely new instrument installation could not be justified. To face the problem squarely, the existing instruments were doing a good job of controlling the plant. With the decision to keep the pneumatic instruments came the task of designing the system on the basis of converting the information existing in pneumatic form to the language of the computer—electrical. It was known at this time exactly which variables were needed, so the question was where to start the conversion. A look at the control panels prior to computer installation would have revealed conventional 3-15 psi recorders, indicators and recording controllers. Included would have been some multipoint temperature recorders and indicators. Here within a few square feet area was the bulk of the information which the computer needed. The decision was to share the 3-15 psi pneumatic input signals used by these various indicators and recorders with commercially available pressure-to-current transducers. This was done by going behind the panel and installing bulkhead tubing tees in the required signal lines. These input signals were grouped into a multiconductor plastic tubing bundle and routed overhead to a panel of rack-mounted pressure-to-current transducers. The computer pneumatic inp[illegible]nel, CPIP, is located across the room from the existing control board. From this point, the computer was fed with the desired input information in the required electrical analog.

As might be expected, the flow measurements were not pressure and temperature compensated. This required the gathering of pressure and temperature information. In many cases, the pressures were indicated on the panel as 3-15 psi signals. These were handled as described above. For those cases where the pressure was not available or where a more accurate measurement at the point of flow measurement was needed, new instrumentation was installed to gather the necessary information. Electronic instrumentation was chosen to do this job. By installation of weather-proof instruments at the point of measurement, conversion was made directly from process pressure to current signals. Two-wire dc signals were routed from the field instruments directly to terminal strips located in the computer pneumatic input panel.

The CPIP panel is also furnished high level voltage inputs coming from the analyzers. The oxygen analyzer utilizes a retransmission slide-wire to pick off the voltage signal it sends to the terminal strip in the CPIP. Similarly the chromatographs have a potentiometer for individual components which store a voltage signal proportional to the analysis. These voltage signals are transmitted to the terminals inside the CPIP.

As was the case with the flow and pressure measurements, most of the temperatures were available in the control room at the various thermocouple indicating and recording stations. If they were available, the points were paralleled at the instrument terminal strip and sent out in a multiconductor thermocouple extension wire to the auxiliary computer equipment cabinet which is called the computer analog input/output cabinet (CAI/OP). The thermocouples terminate here in a reference oven held at a constant temperature. The thermocouple signal amplifiers are located in this cabinet and their output goes directly to the computer. In those cases where a particular temperature was not available, a new thermocouple was installed in the

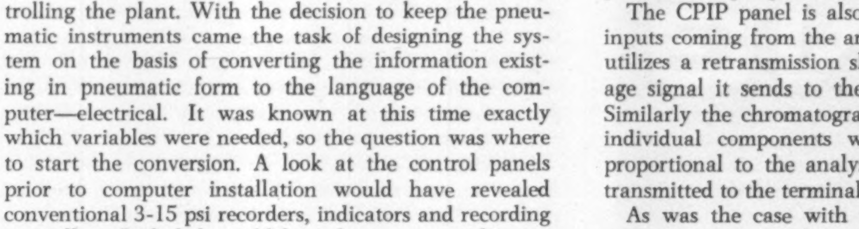
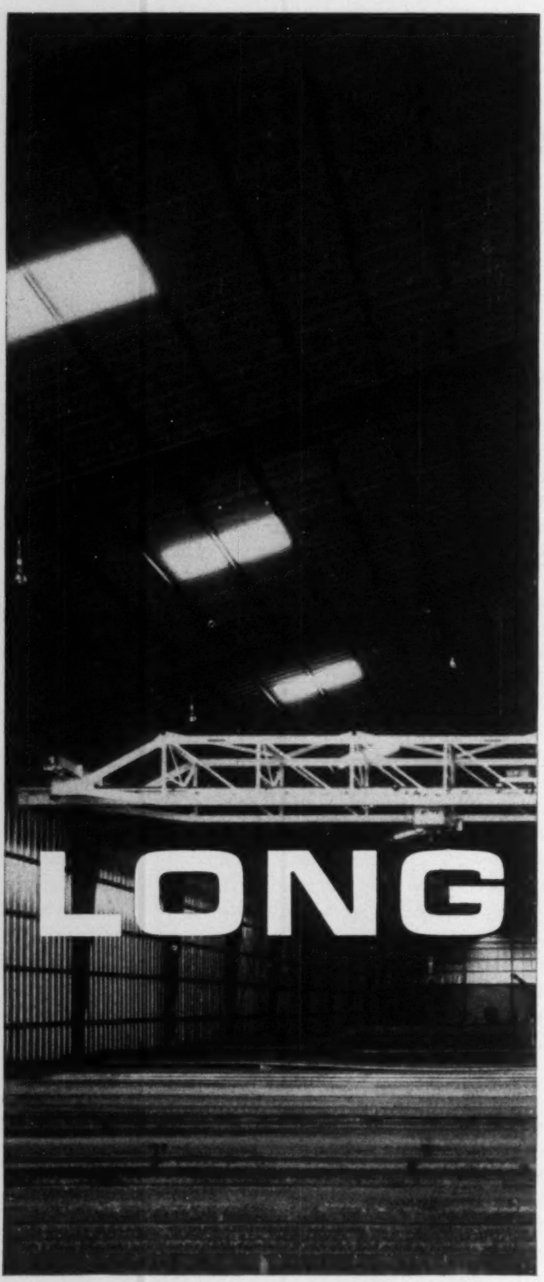


Fig. 1—Portion of ammonia plant under computer control is diagrammed. Final unit in system is synthesis converter in which hydrogen and nitrogen combine to form gaseous ammonia which is condensed by water and refrigeration.



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field and run to the analog input/output cabinet.

The decision to keep the pneumatic system of instrumentation left the problem of converting the computer outputs from electrical to pneumatic signals. Starting at the existing panel board, the particular instruments being used incorporated the mechanical set point feature. For five years this had been adequate for operator control. Mechanically moving this same linkage was not such a simple task for a computer. If the calculated pneumatic setpoint could go directly to a set bellows, the computer could then set the required balance of a force balanced structure and the operator could just as easily turn a hand regulator knob and load the set bellows. The problem then was to equip the control instruments with the pneumatic set feature. Fortunately, the manufacturer was able to convert the instruments to this type operation. The problem of a common means for the operator and computer to set the control point was accomplished. In solving this problem the need arose for giving the operator an air regulator from which he could manipulate the set points. Too, he needed a means of transferring from computer to local control and vice versa. An instrument to fulfill this requirement was found in a small rectangular remote-local type subpanel incorporating a three-way air transfer switch, a dual pen rectangular gage, and a small air regulator. This unit would fit directly below each controller. With these problems solved, it was then possible to receive a pneumatic signal from the computer output transducers and send them directly to the force balance mechanisms of the controllers. With the transfer switch on the instrument subpanel in the local position, the operator had the same control of a variable as he always did except that he changed air pressure on a bellows instead of mechanically changing the linkage. The job of converting the electrical computer output signals to 3-15 psi pneumatic signals was a relatively simple task because equipment was commercially available to do this.

In designing a computer system, there is much information that must be fed the computer to keep it oriented. The computer must know if each instrument is under operator or computer control. To the shaft of the three-way air transfer valve on the subpanel of each instrument, mercury switches were clipped. From these mercury switches, the computer receives the open and closed circuits necessary to identify the mode of control. The "one-bit" inputs from the subpanels are programmed so that portions of the process control calculations will not be made if the proper variables are not on computer control.

External Alarm and Failsafe Devices

Realizing the operator's need for a centralized visual display of the status of his control system, the operator's desk or console was equipped with a bank of indicating and output warning lights. Each computer controlled variable is represented on the console by a two-lamp, low voltage pilot. One bulb is white and indicates whether the variable is under computer or operator control. The other is a red bulb which indicates either high or low limit on the output. For the variable on-off control signal, we utilized another mercury switch mounted on the shaft of the "computer-local" transfer valve on the instrument subpanel. When a variable is on computer control, the mercury switch is open and the indicating light on the console is off. The other half of the indicating light on the console, the red (warning) light, signals to the operator that the output has reached a preset high or low limit. This alarm condition is detected by a pressure switch sensing the output pressure. The high or low contact of this pressure switch actuates a relay in the centralized relay panel. This relay performs three functions. It turns on the low voltage red light, sounds the alarm, and closes a solenoid valve in the transducer output line which seals the pneumatic signal at the high or low pressure limit. On abrupt changes the pressure switch senses the alarm and seals off pressure very quickly. The solenoid valve can have the pressure sealed off before the setpoint air pressure has time to change appreciably. The real value of this design is realized during power failures. In the event of a power failure, all variables seal off at approximately the set point they were carrying. The operator then goes to each subpanel to put the instrument back under operator control.

From a paper entitled "The Relationship of Existing Primary Measurement to Complete Computor Control" presented at Ninth Annual Instrumentation Conference, sponsored by School of Engineering, Louisiana Polytechnic Institute, Ruston, La., November 1960.

PROGRAMMED TESTING

By W. S. BENNETT
Senior Designer
Designers for Industry Inc.
Cleveland, Ohio

BENEFITS to the test department are only the beginning of the advantages of numerically controlled testing to the manufacturing company as a whole. A numerically controlled test system can be the basis of a quantitative grasp on product quality which can reach throughout the organization.

The first benefits are to the production line itself. Especially if it is a fast production line, into which it is normally infeasible to insert intermediate test stations simply because the testing cannot keep up with the production rate of the line, numerically controlled testing can bring important savings. Partially finished products may be tested at any stage of manufacture, and the faulty units ejected—minimizing the amount of good work put into units that are already useless. For instance, in a production line making kitchen utensils, a fast, numerically controlled test station just after the body-forming process but before the attachment of handles would save good handles plus the work required to attach them.

Numerically controlled testing, with its capability to make 100 per cent testing economically feasible, plus its ability to produce tabulations and chartings of its findings, offers quality control—and through it, manufacturing—a way of keeping much closer track of drifts in product quality due to variations in manufacturing machines. It is, of course, true that a sample, properly taken, can reveal these variations as well as 100 per cent testing can. However, the timing is much closer with numerical control—variations

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are noticed instantly and automatically, and the testing machinery can even be designed to sound an alarm when (for instance) a certain percentage of the last 100 pieces made are out of specification. In addition, it is becoming more economically feasible every day to have transducers directly on the manufacturing machines, recording the variables (of the machines themselves) that are most suspected of causing product variations, with a statistical analysis being automatically performed using this data plus that obtained from the numerically-controlled testing of the product. Such a system not only sounds the alarm, but pinpoints the trouble in the manufacturing machinery.

Not only in the semiconductor industry, but in many others as well, customers often require products or parts with special characteristics or special tolerance ranges which are tighter than the usual. A good example might be the small neon glow lamps which are sometimes used as logic elements in electronic circuits: Normally they have firing voltages which vary as much as (for one type) 15 volts from unit to unit. Reliable circuit design demands that this value be kept much closer, for instance, to ±3 volts. But the large majority of users of these glow lamps use them as lamps, not as circuit elements, so it would not pay to grade them all to this specification. Numerically controlled testing offers an ideal way to satisfy every customer: The sales department takes his order for the exact tolerance range he needs, the price being higher as the range gets tighter. This information is put into punched cards or tape along with all the other information flowing back to the factory from the sales office. There it is simply inserted into the testing machinery, which fills a bin with the required number of glow lamps of the desired specification, permitting the "failures" to go on and be sold for the usual purpose of illumination.

In this case, the effectiveness of the sales department has been directly affected by the presence of numerically-controlled testing in the plant. The salesman has a new feature to offer—greater flexibility along the price-vs.-quality curve—a feature that cannot be offered where completely manual methods of testing are employed.

Since products can be graded so exactly, they can also (as implied) be priced exactly, and their costs of manufacture pinpointed more closely. If the automatic statistical analysis of manufacturing machine variations, mentioned above, is used, the contribution of each machine in the plant to the final net worth of all the products manufactured can be determined. This is a cost accountant's dream—and it offers management a degree of control over costs and machine replacement unheard of five years ago.

Certain military procurement programs, in an attempt to increase the reliability of electronic components, have required that every single unit be accompanied—throughout its life in the end equipment—by a record (normally kept as a punched card). On it, its parameters, date of manufacture, date of installation, perhaps hours of use, and date and type of failure are recorded. This information can then be

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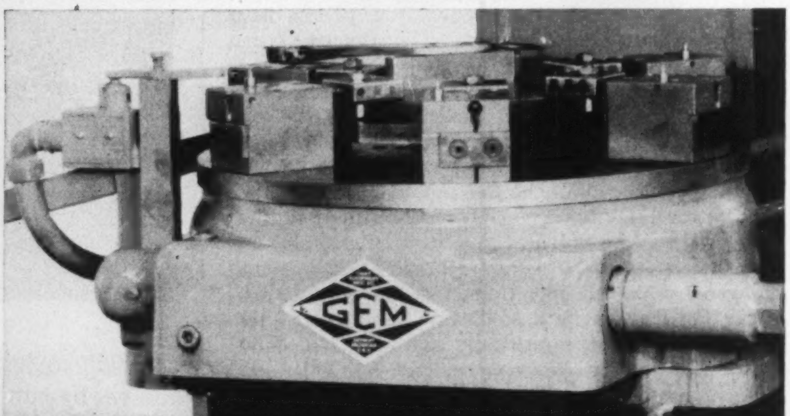
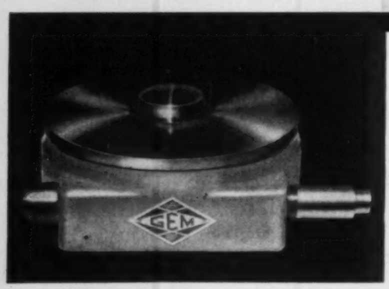
RUGGED 1000 lb. work load with solid anvil capacity of 30 tons.
POSITIVE LOCK Bolt in Geneva slot cammed both in and out given positive locking.
POWER Comes complete with rotary air motor, solenoid valve with limit switch (fluid or electric motors available).
NUMBER OF STATIONS 6, 8 or 12 standard, 3 and 4 skip.
SIZE AND WEIGHT 200 lbs. complete with 17" dia. table (plates up to 36" available).



GEM-17 mounted on GEM ATP-6, 6 ton toggle press with standard GEM base.



Geneva Motion GEM-17 Indexing Table standardizes automation on your assembly and machining operation . . . drilling, tapping, riveting, spinning, staking, knurling, chamfering, welding, screwdriving, stud driving and gaging to the speed and accuracy required. Gray's complete engineering staff can adapt the table to your work problem.

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fed back and compared with similar information compiled about the manufacturing machinery at the time of the unit's manufacture. From this data, computers boil down a statistical analysis which may connect manufacturing practices with definite kinds of in-service failures.

This sort of thing is, presently, too expensive to do with ordinary commercial or industrial products—nor is there the vital need, in most cases. However, if a plant has numerically controlled testing, it is not much more to add a facility to produce a printed or punched card notation of the parameters (specifications) of every single unit. It may even be punched into a card-like pallet which is carrying the unit through the tester. This notation then follows the unit into the field, serving as vital information for the field service engineer who is trying to understand why a particular product has failed. If the card pallets are kept with the end equipment, to be mailed back in by the service engineer as part of his report, engineers at the plant will have a much closer feel for what is important in a product than they could otherwise have.

From a paper entitled "Numerical Control—Complete Integration of Product Testing with a Manufacturing Business," presented at American Society of Tool and Manufacturing Engineers National Seminar on Automation and Numerical Control, Hartford, Conn., February 1961.

IMPROVED MANUFACTURING FLOW

By K. M. PATTERSON
Manager, Headquarters Sales
Westinghouse Electric Corp.
East Pittsburgh, Pa.

MOST companies are not short of production capacity with which to meet the projected demands of the next few years. But there is a marked shortage of efficient low-cost capacity—the kind that determines the company's success or failure in the market place. Most capital spending in the near future is expected to be for the modernization of existing plants. More than any other factor, it is automation that will determine the design of tomorrow's plants.

The progress we have made during the past ten years in production efficiency has been significant. But now we have started into an era which utilizes all the concepts of automation. Through the application of on-line computers there are installations in industry which take the raw material, process it, make adjustments and corrections in settings or operations as necessary through self-correcting systems, and finally deliver the finished product.

The real meaning behind these complicated controls and systems is that they result in closer "management control" of productive operations. The use of punched cards, various forms of tape, programming control, computer control, or other means of feeding management intelligence into productive processes are making many such systems a science, subject to rigid control, rather than an art.

The basic approach is one of improved manufac-

R-W OVERHEAD CONVEYORS
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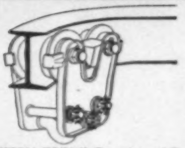
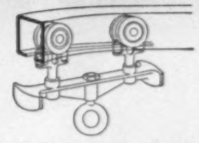
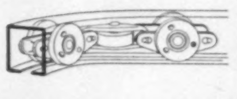


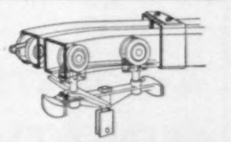
R-W "TRU-TRED" Overhead Track Systems . . . heavy-duty Monorail Systems capable of carrying up to 8,000 lbs. Available in a complete range of sizes. Designed to provide years of dependable trouble-free operation. Request Catalog No. A-64.



R-W "SAFE-RAIL" Overhead Conveyors include a complete range of enclosed trolley track and equipment that will easily handle up to 1,000 lb. loads quickly and efficiently. Request Catalog No. A-94.



R-W "ZIG-ZAG" Continuous Powered Conveyors. Extremely flexible . . . carries unit loads up to 125 lbs. Economical to purchase and install. Easily modified, relocated or extended by plant personnel. Request Catalog No. A-93.



R-W "TWIN-TRAK" Overhead Automatic Dispatch System consists of one or more power tracks and as many free or storage tracks as desired. Provides automatic selective control over product movement through an entire plant. Request Catalog No. F-192.

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Circle 729 on Page 35

VIBRA-WASHER
. . . THE COMPLETELY NEW AUTOMATIC PARTS WASHER AND METAL CONDITIONING MACHINE

- **Labor saving**
- **Automatic unloading**
- **For single or multi-stage operations**
- **No nesting of parts during cleaning or conditioning cycle**
- **Adjustable capacities to 10,000 lbs. per hour**

The versatile new Simplicity VIBRA-WASHER, revolutionary machine for washing and conditioning of small metal parts, stampings and castings, employs a vibrating work carrier that automatically conveys parts through cleaning or conditioning bath. Solution is forced around parts, even into blind drillings and slots. In single stage, VIBRA-WASHER removes chips, oil and grease quickly . . . economically. In multi-stage, several units in line will provide cleaning, rinsing and phosphating, eliminating "between-stage" handling. Write today for Bulletin 107, to: Industrial Washer Division.

Simplicity
TRADE MARK REGISTERED
212 ENGINEERING COMPANY • DURAND 26, MICH.

Circle 730 on Page 35

AIRMATIC
MINIATURE
AIR CYLINDERS

compact, space-saving and easily installed

Wherever space is at a premium, Airmatic Miniature Air Cylinders are today's number one selection for aiding in dependable, maintenance-free automation.

For activating electrical contacts in test jigs and fixtures—as miniature air vices—in automatic work for feeding, ejecting, soldering and many other applications. In fact, applications are limited only by the ingenuity of industry's design and production engineers.

Shown here, for example, is Airmatic No. C-1125 mounted on the gravity feed chute of a vibrating parts feeder.

The complete miniature line (with bores of ⅜", ½", ¾", 1", 1⅛", 1½" and 2") are designed with thick brass tube walls.

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turing flow. This is simply another way of stating that the most important single common denominator is materials handling. Any improvement for production efficiency must start with improved planning, which results in the most efficient flow of the product through the plant. It is, of course, unrealistic and uneconomical to build any type of sophisticated automatic control into a manufacturing process until the material handling aspect has been analyzed completely. This includes such well-known tools as three-dimensional layout, bottleneck analysis, and a general knowledge of the production machinery or equipment used. It is important that fundamental equipment policies be thought out and adopted as guides. Manufacturers of any size should have an awareness of the cost per day of their floor space. If there is equipment not being used, or being used but not absolutely required, it should be retired.

If a saving of 20 per cent or more can be gained from investment in a new facility, the new facility should be carefully considered. The age of the equipment replaced should not be a factor.

Now these are not modernization sales plans, they are economic facts of life in today's manufacturing economy. Years ago we built plants in which we didn't expect full capacity operation for five years. Today we build them for full capacity output the first year. We obtain the added volume from continuous facilities improvement. Materials handling devices do not have to be 20 years old to be uneconomical.

Earlier I said that the common denominator to all areas of production efficiency was materials handling. There is little doubt but that the cost of moving the product through the plant is at least one-third of the manufacturing cost. An engineer from Ford Motor Co. has stated that this cost could be as high as 55 per cent of manufacturing cost. So it is obvious that this area will continue to offer opportunities more unlimited in this decade than in the past. If there is a way to approach this opportunity, it would seem to me that the key is method. This means to look at materials handling as a part of the plant system. How is the job being done? Is it really integrated into the whole operation?

Probably the most general application for new methods in this decade will be in combining operations into a production system. Look at a well-known example: Numerical control on machine tools and transfer machines. As you well know, this new technology combines considerable materials handling into the machining line. This is certainly a drastic change in method. What does it mean to the materials handling industry? I think it presents the same challenge—new methods to combine operations. At Westinghouse we call it the systems approach. It requires much greater investment in the machine tools and production equipment, their drives, and especially their control. But it implements movement of the product through the plant, adds to the efficiency obtained, controls quality and reduces cost.

From a paper entitled "This Decade in Materials Handling," presented at Seventh Biennial Materials Handling Conference sponsored by Westinghouse Electric Corp., Pittsburgh, October, 1960.

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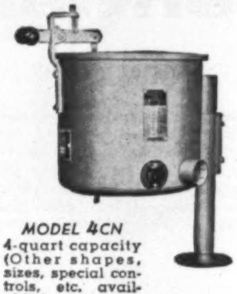

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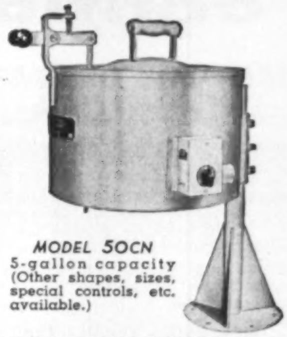

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Circle 732 on Page 35

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TO SOLVE NEW PROBLEMS

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Circle 734 on Page 35

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Circle 733 on Page 35

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PAN OR PALLET CONVEYOR

One continuous system — operating at floor, table or ceiling levels — up, down, around curves

One American "Chainless" Conveyor, with a single drive unit, can do work which otherwise requires a complicated system of powered belt or roller conveyors with a number of drive motors and transfer points. The continuous "Chainless" conveyor negotiates horizontal or vertical curves, and can be extended to almost any length. Pallet attachments can be used in place of pans. Eight-wheeled trolleys have exceptional stability. Write for Catalog CD-B.

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Circle 735 on Page 35

counts...

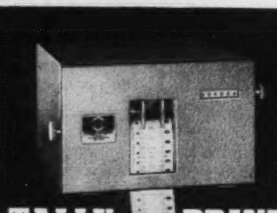
1270 **prints totals...**

3829 10 PM **keyed to time!**

1045

3746 9 PM

0981



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PRINT-OUT RECORDER

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Tally-Print shows **how much** production you get—and exactly **when** you get it!

Machine production, gallons of gas pumped, cash register sales, conveyor traffic—are but a few of the operations monitored.

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Circle 736 on Page 35

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CASE 2303-P

MEASURING TENSILE TEST SPECIMENS

. . . I am looking for a solution to the problem of measuring the cross section of a tensile test specimen. This means measuring the width and thickness or diameter, depending upon the shape of the specimen. The measurements are to be obtained before starting to pull the specimen and also at the cross section at time of failure, the latter to enable us to obtain a reading for calculating the per cent reduction of area. The equipment should be able to read to one whole number and to the third decimal point . . .

Staff Metallurgist

CASE 2304-P

HANDLING GARMENTS

. . . We have an excellent spot for automation if I can locate the proper machines. In our assembly lines, labels and pintickets are put on individual garments with hand operated machines. Folding, bagging, boxing, and marking are also done in the same manner. We would be interested in contacting manufacturers who can provide equipment to do these jobs automatically. . .

Plant Engineer

SUGGESTIONS FOR 2295-P (FEBRUARY 1961)

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. . . It is a practice among glass blowers to deposit a thin film of soot, by means of a strongly reducing gas flame, on the hot walls of a mold. This prevents fluxing or adherence to the walls. This film radiates heat at the glass contact, congealing superficially and allowing the interior to slowly cool with fewer stresses. The carbon is burned off in the strongly oxidizing annealing cycle, or rapidly passed through a strongly oxidizing flame or oxygen enriched atmosphere. No detectable residue remains, metallic pickup from mold is avoided, dielectric constants are unaffected, and most colors survive, if an oxidized state is maintained. . .

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Circle 737 on Page 35

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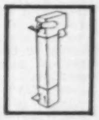
Automatically–
ELEVATE YOUR SMALL PARTS *Magnetically*
WITH THE

MAGNAVATOR

TUBE-VEYOR

PARTS FEEDING CONVEYOR



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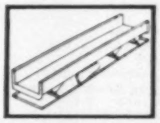
MAGNAVATOR eliminates manual labor usually required for filling hoppers and transferring between machines . . . conserves valuable floor space . . . automatically handles up to 8000 lbs. per hour . . . serves two or more machines. The self-feeding **MAGNAVATOR** efficiently handles small parts up to 8 lbs. each, such as castings, bolts, nuts, forgings, rivets, stampings, etc. The automatic **MAGNAVATOR** can greatly reduce your materials handling costs.



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Advantages: Self-feeding · maintains material level automatically · pleasing appearance, portable · vertical handling saves floor space · hot parts can be handled · no jamming · each unit engineered to YOUR specific requirements.

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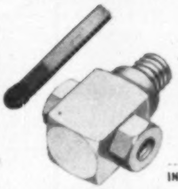
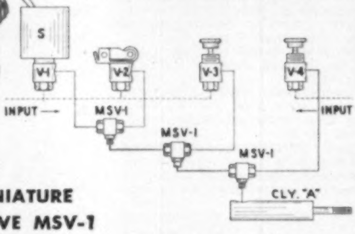
HOW TO "MULTIPLEX" A MACHINE!





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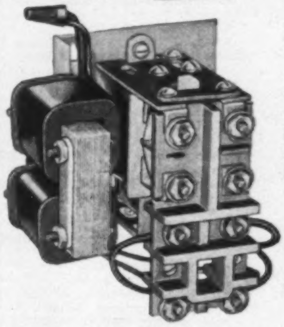

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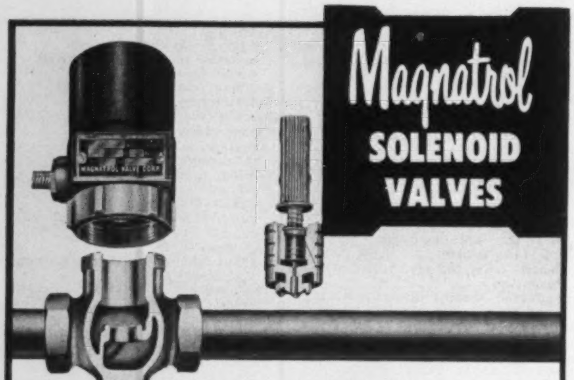

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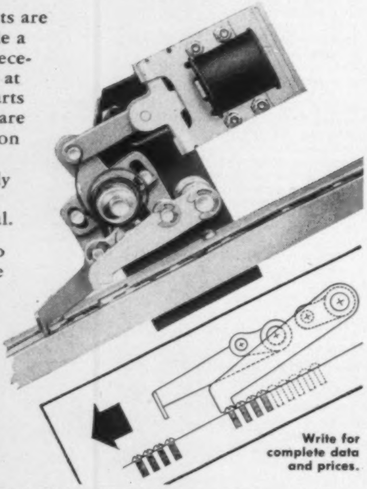

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IBM
MANUFACTURING
RESEARCH

IBM is now organizing a nucleus of highly skilled people to provide leadership in advanced programs at our Manufacturing Research Laboratory, Endicott, New York. These programs are designed to insure that our manufacturing operations keep pace with the most advanced Product Development programs.

The Laboratory needs men who can contribute ideas in significant new areas of manufacturing process development work. They should be capable of identifying and quantifying parameters vital to this work. If you have a high level of expertness, demonstrated ability in the problem areas, and an advance degree, we would like to tell you more about these programs.

CONTROL SYSTEMS

Working both independently and as a team member with men of related specialities, you will be participating in, and guiding, new work to establish fundamental parameters for higher speed assembly and for test equipment of greater versatility and dependability.

You should have an advanced degree and experience or thesis work, in the electronic control field, i.e., sample data, nonlinear and conventional systems. Possible areas of your work will include adaptive control, stability of linear and nonlinear systems, and data sampling systems.

ELECTRONIC DESIGN

A good academic record is required and one to five years of experience in relevant areas. You will be working in one or more of the following areas:

* Circuit design using network synthesis and probability theory.
* Adaptive control systems.
* Servo system and component design.

Applicants will be considered without regard to race, creed, or color or national origin. For further information about this new work at IBM Manufacturing Research, please write outlining your background and experience, to:

J. E. Monico, Dept. 521E
Manufacturing Research Laboratory
IBM Corporation
Endicott, New York

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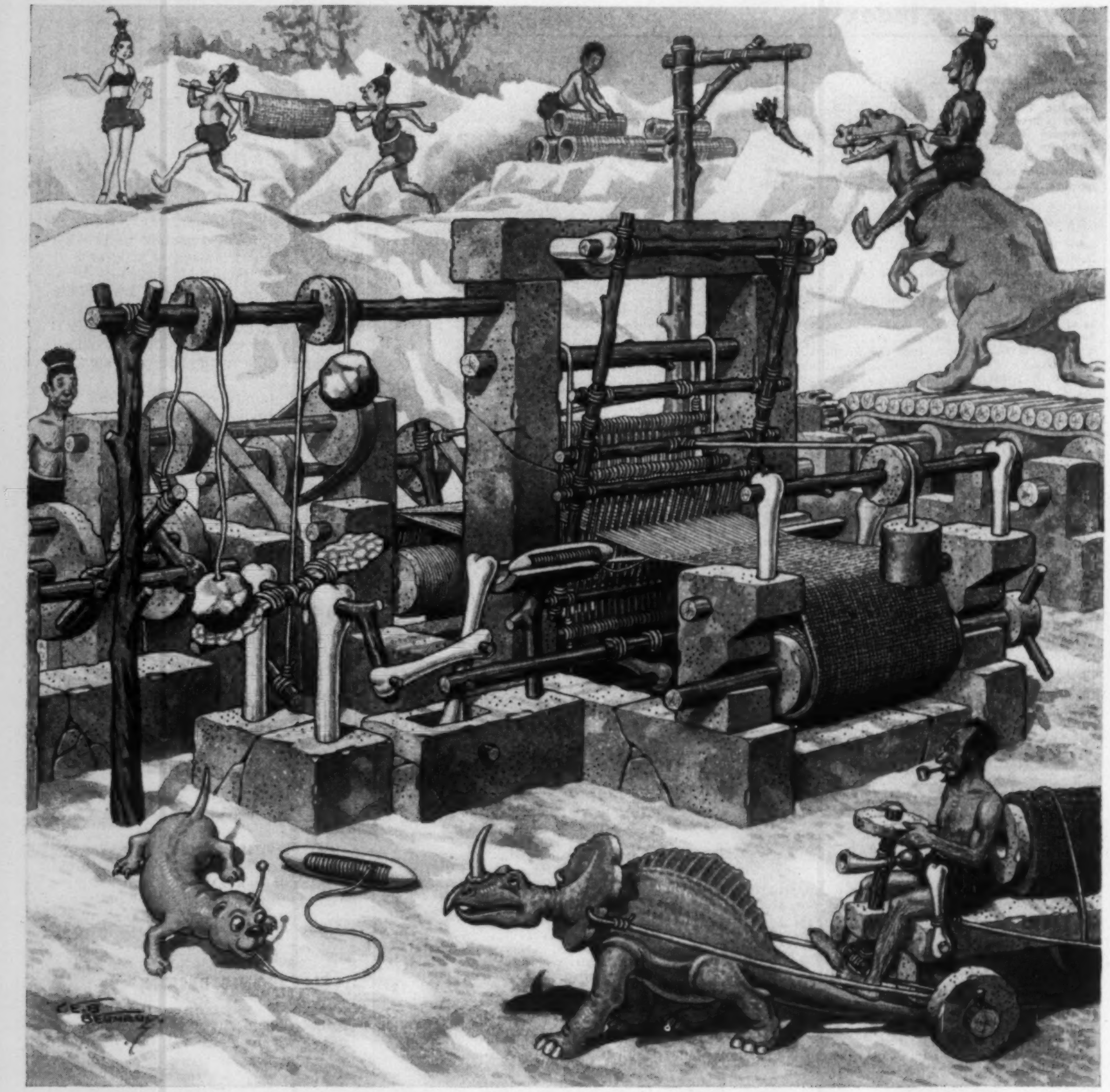

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This backward look at the backward days of automation is lovingly dedicated to industry everywhere by Barkley and Dexter with this reminder: that industry anywhere can progress and profit from the forward looking services of B & D, one of the nation's foremost specialists in industrial mechanization and automation.

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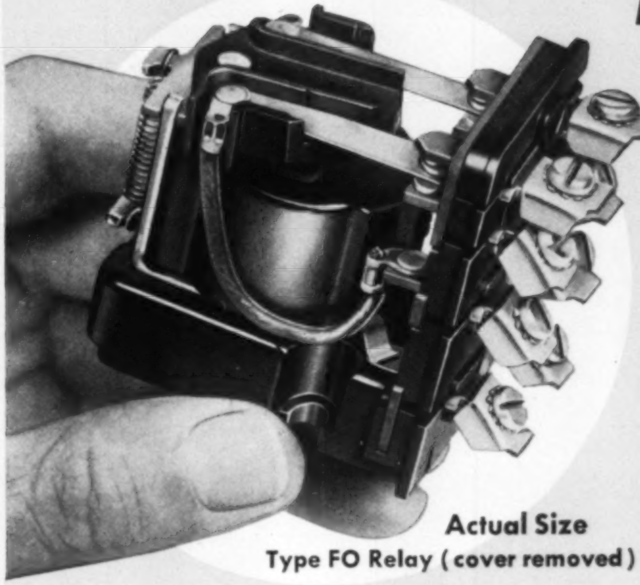

Actual Size

Type FO Relay (cover removed)

Terminal or Plug-In Wiring

- **RATINGS** easily handle solenoid loads. AC pilot duty rated 690 VA. Continuous rating 10 amperes, 125 volts AC for plug-in construction and 277 volts AC for terminal connection
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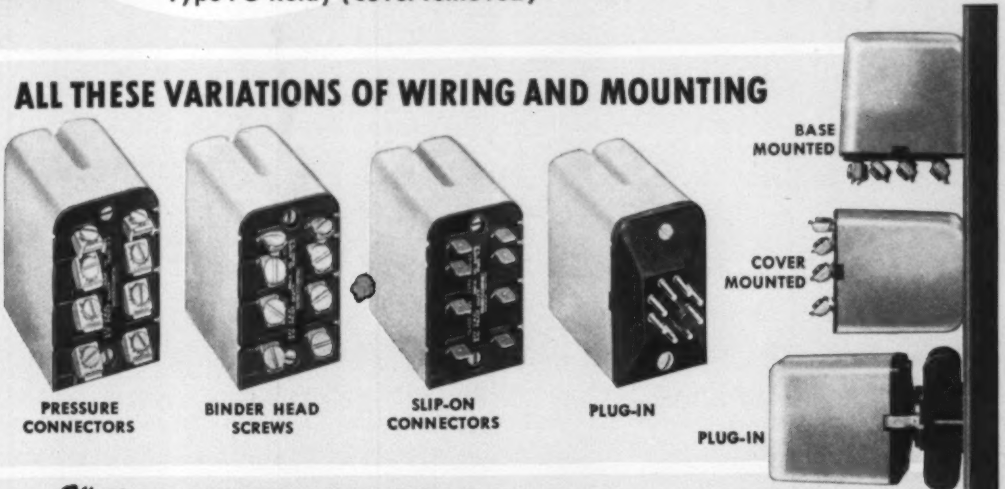
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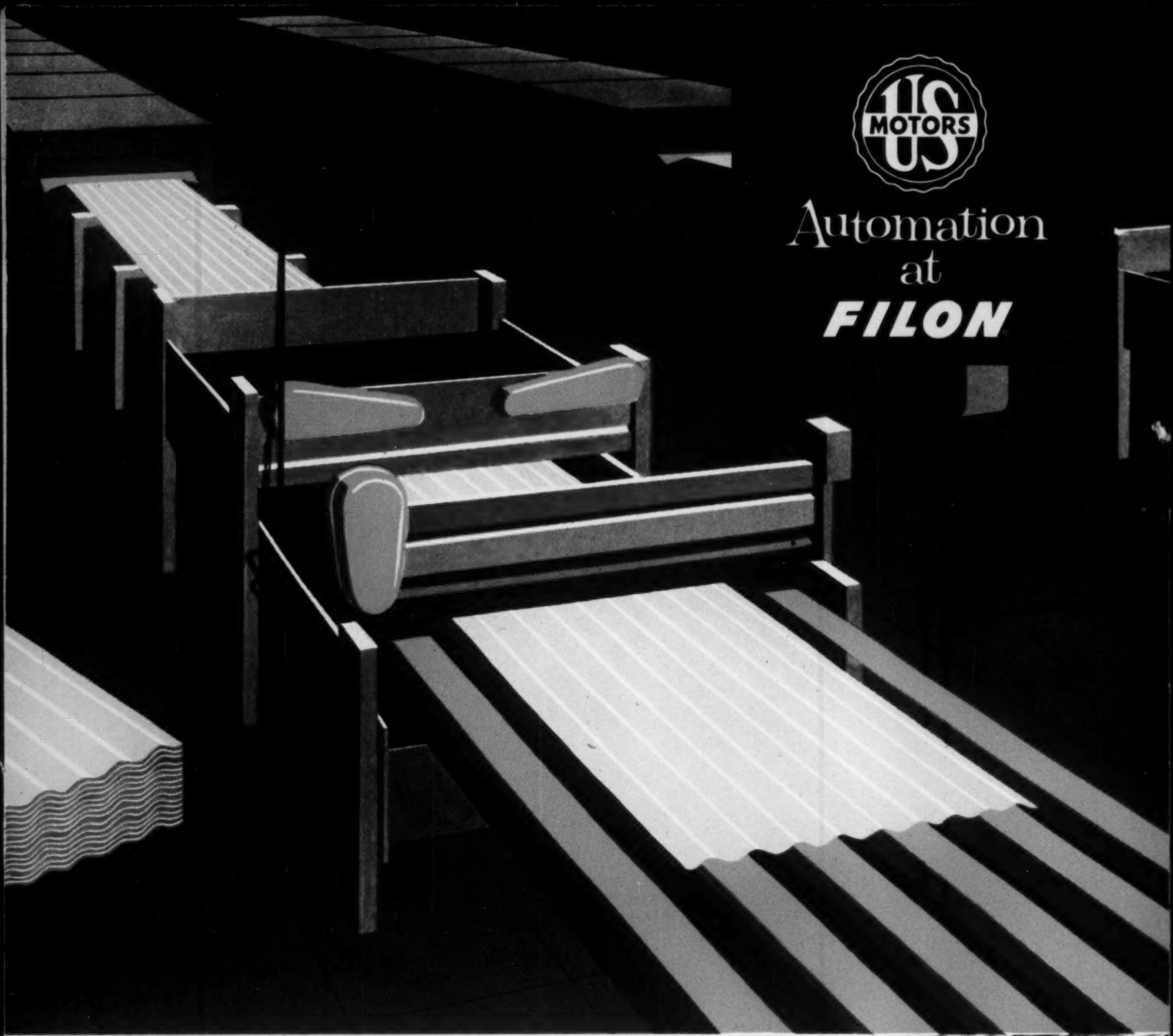

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